Shortage Engineering

THE ENGINEER

APRIL 16, 1954

Institution of Naval Architects' Annual Dinner

NEARLY nine hundred members and guests attended the annual dinner of the Institution of Naval Architects which was held on Wednesday, April 7th, at the Connaught Rooms, Great Queen Street, London, with the president, Viscount Runciman of Doxford, in the chair. The Minister of Transport and Civil Aviation, Mr. A. T. Lennox-Boyd, proposed the toast of "The Institution of Naval Architects," commenting that the Institution was founded in a period of revolutionary development and a few years after the formation of the Board of Trade and the passing of the Merchant Shipping Act. With regard to the latter, he reflected upon the rapidity with which the Parliament of the day passed the hundreds of clauses compared with the speed of progress at the present day. The Minister recalled the remarks made by Mr. Walter Runciman, the father of the president, at the Institution's Jubilee, upon the complexities of ships and wondered what he would have thought about the ships of to-day. He went on to mention briefly new improvements and the co-operation of the shipping industry in helping to solve the problem of oil pollution. In his reply the president referred to the Royal Yacht "Britannia" and was emphatic that no expense could be considered excessive for a ship in keeping with our position as a maritime nation to take the Queen and the Duke of Edinburgh to their Dominions. Viscount Runciman considered next the position of shipbuilding and shipping to-day, saying that costs were too high to tempt shipowners to place orders when freight rates were at a low level. He felt that there was enough tonnage to meet world demand so that orders were limited to the replacement of ships as they became obsolete. Foreign yards, he went on, promised quicker delivery and quoted fixed prices which were lower than British despite the fact that British steel cost less. However, it was not easy to build cheaper ships, although the break down of rigid demarcation rules would help. He thought, however, that the right kind of research could help to build better ships. Sir Harold E. Yarrow proposed the toast of "The Guests" and the Honourable Sir Thomas White, the High Commissioner for the Commonwealth of Australia, replied.

Extension at the National Physical Laboratory

AN extension to the Metallurgy Division at the National Physical Laboratory, Teddington, was opened last week by Professor Sir Lawrence Bragg. The main object of the extension is to accelerate the examination of the fine structure of metals and of their high temperature characteristics. It is a two-storey building of about 11,700 square feet total floor area, and will accommodate an X-ray section, a new radioactive tracer section and a ceramics section. The ceramics section will be concerned with the development of methods by which the properties of refractory materials at very high temperature can be measured. On the ground floor also are three rooms, comprising the radioactive tracer section. The immediate research programme here includes the development of more sensitive techniques for measuring the activity of very small amounts of active material, investigations such as those concerning the identification and distribution of constituent elements in a metal; studies of diffusion and the determination of extremely small impurity levels in metals. This section has a well-equipped foundry, a workshop, a small rolling mill, and a combined chemical and physical laboratory. The active extract plant is contained in a fourth room, and to avoid contamination the air conditioning system of the whole section is completely independent and maintained at a relatively lower pressure than that of the rest of the building. All fluids leaving this section are passed either through delay tanks or inspection tanks. The arrangement of the X-ray section on the upper floor was highly commended during the opening by Sir Lawrence Bragg. It is divided by easily removable partitions into a number of cubicles and small laboratories, each of which is intended to contain a single piece of equipment and has independent lighting control. Equipment not required by immediate programmes may be readily removed from its cubicle and placed in store, and its space employed in building up the equipment for some developing type of work. In addition to the standard services, a circulating system of clean distilled water at 50 lb per square inch pressure and 20–25 deg. Cent. temperature for cooling purposes, and a single-phase, 230V a.c. supply for apparatus requiring short-term stability is provided. The X-ray units in four of the cubicles are primarily intended for standard X-ray techniques, but there is ample space for ancillary equipment. The remaining two cubicles have X-ray sets for Geiger-Müller counter work. In the centre of the building, also opening on to the same common working space, is a cubicle containing an X-ray set for work requiring a fine focus source of radiation. There is a preparation room for electron microscopy, opening into a central cubicle housing the microscope, a soft X-ray spectrograph and a recording microphotometer. The ceremonial key had sections made from ten different elements and alloys to symbolise fifty years of metallurgical development.

Demonstration of Soil Stabilisation

ON Monday last, a demonstration of the use of soil stabilisation plant was given by Rotary Hoes, Ltd., at that firm's new premises at Basildon. The soil stabilisation equipment made by Rotary Hoes, Ltd., is for single-pass stabilisation. It is driven by tractor and consists of two units—first, a pulveriser and mixer, which incorporates water spraying apparatus and a cement spreader, and which has a power take-off from the tractor; and second, a compactor, which incorporates its own power unit and comprises a rotor, for further mixing, a screed, and a compacting unit of six 5-cwt blocks which are successively dropped, by a cam mechanism, into the surface to be consolidated. Dr. W. H. Glanville, the Director of the Road Research Laboratory, was present at the demonstration and gave a short address, in which he spoke of the importance of efficient plant for road construction. In his opinion, a large-scale programme of road construction was inevitable in the near future, when all such equipment would be in great demand. The saving claimed, over normal construction, by the use of this method of soil stabilisation is about 7s. to 8s. per square yard, and it is stated that the machine developed by Rotary Hoes, Ltd., will extend the range of soils that can be stabilised further into the clay range. A paper on the more theoretical aspects of soil stabilisation was published in THE ENGINEER of November 27, 1953.

Manchester University

IN parallel with its conventional degree course, Manchester University is now offering an alternative in mechanical engineering. In introducing the course it is remarked that among the students taking courses of the conventional kind there are many who by aptitude or interest are not well catered for by the somewhat rigid analytical approach which has frequently been adopted in relation to theory or the equally synthetic approach to design or application. These men will not find their way into higher circles of advanced design and development. Their proper work will be in the diverse branches of manufacture and management requiring a somewhat broader outlook, and an ability to handle problems involving a multitude of factors—many of which may be conflicting, and in which human relationships play a prominent part. Such men should be well grounded in the fundamentals of engineering principles and theories and have a keen appreciation of their applications. In the course now available at Manchester the two streams of engineers will not be separated till the Part I Hons. (or Final Ordinary) level has been achieved. In the final year, however, a considerable divergence will occur. Statistics will appear in a modified mathematics syllabus, materials and structures will follow the normal course for mechanical engineers, and special subjects will be electrical measurement, control mechanisms, including electrical and fluid control methods, theory of metal processing, metrology, production control and management principles. The normal course on design will be replaced by designing for production and the planning, supervision and inspection of production processes. For some years the College has been building up its facilities for such a course. For students who have already taken a first degree in mechanical engineering elsewhere it is thought that this special final year may prove of interest as a diploma course.

Lloyd's Register Annual Report

LLOYD'S REGISTER OF SHIPPING has published this week its annual report for 1953. It shows that the mercantile fleet of the world has reached a total of 93,351,800 tons gross, which is an increase of 3,271,431 tons over the previous year, while oil tanker tonnage now stands at 21,963,937 tons and represents 23·5 per cent of the world total. The tonnage of individual countries is set forth in the different age groups in tabular form, and indicates that 18 per cent of the world tonnage is over twenty-five years old. In the report another table shows the flag distribution of the world tonnage, the amount owned by the British Commonwealth being 23·95 per cent, which compares with 24·76 per cent in the previous year and 30·66 per cent in 1939. The ships completed to class numbered 594 of 2,948,631 tons gross, representing an increase of 70 ships of 425,690 tons over 1952, and nearly 60 per cent of the total world tonnage. According to the report, the work in hand, estimated at 4,161,000 tons, was 66 per cent of world construction and included 2,379,300 tons gross of oil tankers. It is stated in the report that plans for 585 ships of 2,378,500 tons gross were approved during the year, 1,191,620 tons to be built in the United Kingdom and 1,186,870 tons abroad, both figures being considerably less than 1952. The number and tonnage of ships classed with the Society increased by 63 and 1,668,505 respectively to bring the totals to 9948 ships of 39,350,544 tons, and the report mentions that 1,840,486 tons of ship and boiler steel were tested by the Society's surveyors. In the report the adoption of longitudinal framing at bottom and deck is recommended, and it is noted that construction has begun on the gas turbine propelling machinery for a tanker and that the Pescara free piston engine in conjunction with gas turbines has been installed in a coaster. The methods of propulsion are analysed in tabular form to indicate the trend since 1928, and another table records the fuel analysis of world tonnage to indicate that 87 per cent of the world tonnage now burns oil fuel.

Some Recent Swiss Hydro-Electric Schemes

No. II—(*Continued from page 520, April 9th*)

The general layout of the Mauvoisin and Grande Dixence schemes in the Valais canton was described last week. Some further details of the Grande Dixence scheme are given below, covering the main dam—a gravity structure, 922ft in height—and the various other large-scale constructional works now in progress in the Val des Dix.

THE Grande Dixence dam is to be a gravity structure with a maximum height of 922ft. It blocks a defile near the source of the Dixence River, at a site several hundred metres downstream from the existing dam. Its height makes it a considerably more ambitious dam than any constructed so far. In spite of that fact, its design has apparently followed conventional lines for a gravity structure, and elaborate stress analyses have not been undertaken. The rock upon which the dam is being built is a gneiss of good quality, and would have been strong enough, apparently, to take a certain side thrust, such as would have been caused by an arch dam. Considering the enormous saving in concrete which would result if an arch or arch gravity structure had been adopted, it may be wondered why a gravity design was chosen. Further consideration of the site answers this point. The immediate surroundings are extremely steep and rugged, such that access is difficult (by one tortuous road) and there is little facility for placing the large installation of plant necessary to build the dam. The greatest difficulty has been in placing the cableways (their position is shown in the plan, Fig. 4), and it has been necessary to group the headmasts into a single steel tower on one side of the dam. On the opposite side the track carrying the movable tail carriages is sloped at 35 per cent. The configuration of the rock here did not allow of the construction of a level track, such as is normally considered essential. Had an arch dam been favoured it would have been impossible to extend the tail carriage track sufficiently for the cableways to cover the area of the dam where concrete was required, and emplacement of the concrete would have been a far more difficult problem. As Fig. 4 shows, sufficient coverage has just been obtained for the gravity dam. This is the first time that a sloped track has been used in Switzerland to carry cableway tail carriages.

Hollow and buttress designs were also considered for the Grande Dixence dam, but were rejected for two reasons. For a structure of such height the Grande Dixence S.A. considers, there is little advantage in these designs, owing to shuttering complications ; the maximum advantage is to be obtained, in the company's experience, for heights of the order of 100m, the advantage decreasing for higher or lower structures. Secondly, it was thought that the behaviour of a buttress or hollow dam with a height of 280m was to some extent uncertain, and the more conservative gravity structure could be more safely relied upon.

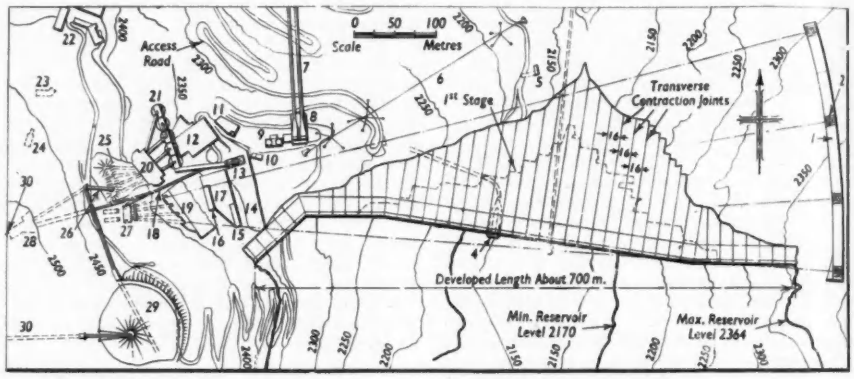
A further point in the design of the dam may be noted from Fig. 4. In plan it is not straight, but follows three straight lines, as it crosses the valley. Thus it follows the best path from the point of view of the foundation rock, keeping excavation to a minimum. There is a cut-off trench under the upstream edge of the dam (not shown in Fig. 5) and cement grout was injected in the rock under it to a depth of 150m, and up to a pressure of 50kg per square centimetre to reduce the uplift pressure. The design calculations indicated a maximum concrete stress of 130kg per square centimetre at the toe with the reservoir full. Vertical and horizontal sections of the dam were analysed and an allowance for an uplift pressure of 85 per cent was made.

The concrete of the dam will be placed in blocks 16m square, in lifts of 1½m (5ft 3in), and cooling pipes for water will be embedded in the concrete. Concreting was just begun last year for a brief period at the end of the constructional season, but the final details of the concrete remain to be fixed as experience is gained this summer in the first full season's work. A concrete laboratory is to be set up on the site, where all the complicated problems of the concrete for the dam will be studied as the work proceeds. As with recent practice in other countries, there will be no masonry facing for the dam and a concrete with good frost-resisting properties will be employed. The aggregate sizes for the concrete are to be 0–3, 3–10, 10–40, and 40–120, in millimetres. Concreting can only be carried out from May to the beginning of October, and a total quantity of 7,550,000 cubic yards will have to be placed to complete the dam. Therefore, as may be imagined, a large installation of aggregate and concrete plant is necessary. An output of 324 to 390 cubic yards of concrete per hour is envisaged when this plant is in full operation. It is the largest installation of its kind used so far in Switzerland and is probably the largest that Europe has yet seen.

The arrangements for the control and diversion of water at the dam site are relatively simple, and for clarity are shown separately in Fig. 6. First, there is a small surface spillway ; there is, of course, little call for a spillway in a scheme of this kind, where the capacity of the reservoir is slightly greater (400 million as against 380 million cubic metres) than the yearly run-off from the augmented catchment area, and more than nine-tenths of the annual flow is retained by the reservoir for use during the winter. Secondly, there is a scour pipe at a level of 2100, which will be used only very occasionally should it prove necessary to empty the reservoir ; the scour pipe is shown in Fig. 4, but not in Fig. 6.

The principal intake is at a level of 2150·5. As Fig. 6 shows, it controls the flow to Fionnay power station, with a branch leading through the pressure reducing device to the existing power station of Chandoline ; it will be noted that the existing Cleuson reservoir is to be led into the new system on the downstream side of the pressure reducer. There is also a connection from this intake to a scour pipe leading back to the river bed, so that the entire flow may be run to waste should it prove necessary.

Excavation at the dam site was carried out by conventional methods, the spoil being removed by steel-bodied lorries (an access road has been built for this purpose) to spoil tips on the mountainside. The quantities involved are given in Table IV, together with various other statistics relative to the dam. A small concrete plant at the bottom of the dam site has provided some of the early concrete, before the main plant was ready. Hutments for offices and personnel have been erected close to the site, at various



1—Sloping track for cableway tail carriages.
2—Mobile tail carriage
3—Scour pipe.
4—Main intake.
5—Pumping plant (constructional) .
6—Ropeway for personnel, connecting lower and upper parts of dam site.
7—Bi-cable cement ropeways from Chandoline.
8—Cement ropeway terminal.
9—Cement storage silos.
10—Compressor house and transformers for concrete plant.
11—65kV switchgear substation (for construction).
12—Workshops and concrete laboratory.
13—Concrete batching and mixing plant.
14—Roadway and ramp for loading cableway skip.
15—Garage for concrete tractors.
16—Joiners' shop.
17—Assembly area for shuttering.
18—Inclined railway leading from concrete station up to cableway head tower and tunnel to quarry.
19—Winch house for cableways.
20—Aggregate plant : washing, screening and secondary crushing.
21—Storage silos for screened aggregates.
22—Accommodation for workers at upper part of dam site.
23—Drinking water reservoir.
24—Reservoir for water for plant.
25—Aggregate storage 28,000 cubic yards.
26—Belt conveyors and recovery tunnels from aggregate storage to aggregate plant.
27—Fixed head mast tower for the four cableways.
28—Operating chamber of service railway from concrete plant and service railway to quarry.
29—Aggregate storage 170,000 cubic yards.
30—Tunnel to quarry at Prafleuri.

Fig. 4—Grande Dixence Dam

TABLE IV—*Grande Dixence Dam*

Maximum height	922ft
Crest level	7,750ft
Top width	72ft
Base width	721ft
Crest length	2,300ft
Concrete volume	7,540,000 cu yd
Excavation :	
Débris	675,000 cu yd
Rock	273,000 cu yd
Longitudinal joint spacing	132ft
Transverse joint spacing	52ft
Water control :	
Capacity of main intake (Fionnay 1520 cusecs, Chandoline 360 cusecs)	1,950 cusecs
Scour capacity of main intake	1,760 cusecs
Capacity of lower scour pipe	350 cusecs
First stage of construction :	
Maximum height	584ft
Top width	50ft
Base width	460ft
Crest length	1,475ft

levels down the steep mountainside ; altogether some 950 persons, engaged on the constructional work, live at the dam and quarry sites. Several of the huts built twenty-five years ago for the first dam were still found to be in good condition and have been incorporated in the larger settlement at present in use.

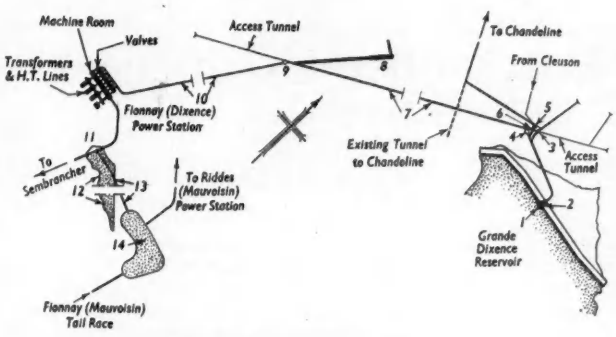
Constructional Plant

Referring again to Fig. 4, it will be seen that the constructional plant at the dam site is grouped on the left bank close to the abutment of the dam. Even here it is laid out on a steep slope at different levels. A ropeway (labelled 6 in the legend) leads to the access road to the lower levels of the dam, and a steeply inclined cable railway (18 in the legend) runs up to the access tunnel to the quarry.

Cement is brought from the yard of Chandoline power station at Sion (which has a siding from the main line railway) by two bi-cable ropeways, which pass up the Val d'Herens and the Val d'Heremence for a distance of about 16km, climbing from the rail level of some 500m to the terminal level of about 2300m at the dam site. Each ropeway has a capacity of 50 tonnes per hour, the cement being handled in containers of 400kg capacity, which are also suitable for rail transport, so that it is a simple matter to transfer them from the railway wagons straight on to the hooks of the ropeway. These containers were developed in Italy and are in use on a number of Swiss and Italian projects. At the dam site the cement is handled by compressed air to the storage hoppers and the batching plant. There are two storage hoppers with a total capacity of 1800 tonnes, and cement may be supplied to the batching plant at a maximum rate of 80 tonnes per hour.

Aggregates are quarried at Prafleuri, which is above the dam site, at an altitude of 2650m. A deposit of moraine situated in two adjacent relatively flat areas is being exploited here ; there is sufficient quantity to allow straightforward excavation for the aggregates for the entire dam. The primary crusher house is at Prafleuri, and there is an access tunnel, 1600m long, leading from it to the dam site. A belt conveyor installation in the tunnel will convey the aggregates to the dam site.

Two flat areas suitable for aggregate storage have been excavated where the Prafleuri tunnel emerges at the dam site. The smaller one (number 25 in the legend to Fig. 4) is for normal working, and the larger (number 29) is to allow a stock to be built up for use in the early days of concreting in the late spring of each year, for the dam site is then free of snow some weeks before it is possible to start work at the quarry. Each stockyard is supplied by a conveyor boom and there are recovery tunnels under them with belt conveyors. From the stockyards the aggregates are taken to the washing, crushing and screening plant.



1—Screens and intake at Grande Dixence dam.
2—Two guard gates with operating chambers inside dam.
3—Sluice gate controlling scour outlets.
4—118in diameter butterfly valve controlling flow to Fionnay.
5—Pressure regulator and energy absorber for Chandoline diversion.
6—Butterfly valve controlling flow to Chandoline.
7—Dixence-Fionnay tunnel.
8—Inclined surge shaft.
9—118in diameter butterfly valve at top of inclined pressure shaft.
10—Steel-lined pressure shaft.
11—Sluice gate connecting with Mauvoisin system.
12—Compensating reservoir of Grande Dixence system between Fionnay and Sembrancher power stations.
13—Tunnel connecting Grande Dixence and Mauvoisin systems.
14—Compensating reservoir of Mauvoisin system between Fionnay (Mauvoisin) and Riddes power stations.

Fig. 6—Water Control at Grande Dixence Dam and Fionnay Power Station

Fionnay Power Station

At the present early stage of construction of the Grande Dixence scheme there is not a great deal that can be said about the three power stations. Excavation is at present in progress for the first of them, which will be built underground at Fionnay. The diversion tunnel from the dam to Fionnay is also under construction and about 3·5km out of the total length of 8km had been driven by last September. The tunnel will end in an inclined pressure shaft, lined with steel, 2·8m to 3·0m in diameter, and 12,226m long ; there is to be a valve house at the top of the shaft (Fig. 6), just upstream, of which the surge shaft will join the tunnel. The surge shaft will also be inclined, with the upper part enlarged to a greater diameter to form the expansion chamber. The tail-race pond of Fionnay power station will have a connection with a similar pond to be built for the Fionnay (Mauvoisin) power station on the opposite bank, so that when the two schemes are completed it will be possible to exchange water between them at this point.

The main data for the three power stations of the scheme are given in Table V. Sembrancher and Martigny will both be surface structures ; but Fionnay power station is underground. The design for Fionnay (which will have six horizontal turbo-alternator sets installed when it is completed, each alternator being driven by two Pelton wheel turbines) comprises a machine hall to house the main sets and a second chamber further in the rock for the valves. At the steep hill-side forming the rock surface three long open-ended chambers will be excavated at the same level as the machine hall, each chamber corresponding to a pair of the principal machine sets. The transformers will be positioned at the inner ends of each of these chambers, with the switchgear in the outer parts so that the high-tension cables of the 225kV transmission line will depart directly from them.

One particularly interesting point in the power station layout is the incorporation of the pressure reducing device at the dam site, which, as already mentioned, will restore the pressure of the waters diverted to Chandoline power station to the amount obtaining now, with the old dam in operation. Originally it was planned to have a so-called *centrale de detente*, viz., a small power station at the dam site which operated between the new head and the old, thus serving to utilise the power at present dissipated in the pressure reducer and generating a corresponding quantity of power for the rest of the flow from the reservoir, and so reducing the pressure acting on the diversion tunnel to Fionnay. Apparently, however, it has been found more economical to design the tunnel for the higher pressure, and to waste the small amount of power necessary to adjust the head acting on Chandoline power station, thus avoiding the necessity of a power station at the remote and relatively inaccessible site of the reservoir. The pressure-reducing device has not yet been finally designed ; the preliminary design, we understand, is somewhat novel and is undergoing hydraulic model tests, so it is too early to be able to include a description of it here.

(To be continued)

Table V—*Power Stations of the Grande Dixence Scheme*

Generating sets	Fionnay: Six horizontal Pelton wheel sets, each with two turbines	Sembrancher: Six horizontal Pelton wheel sets, each with two turbines	Martigny: Four vertical Francis turbine sets
Installed capacity, MW	6×56	6×48·5	4×27·2
Maximum gross head, feet	2,860	2,487	875
Minimum gross head, feet	2,224	2,444	865
Total rated flow, cumecs	45	45	50
Length of intake tunnel, miles	5·28	7·89	2·76
Lined diameter of tunnel, metres	4·0	4·0	4·2
Length of : Pressure shaft, feet	4,100	—	—
Penstock, feet ...	—	4,330	1,360
Diameter of : Pressure shaft, metres	3·0–2·8	—	—
Penstock, metres ...	—	2·2–2·0	2·5–2·3
Number of penstocks	—	2	2
Capacity of tail-race pond, cubic yards	260,000	200,000	—
Length of tail-race channel, miles	—	—	1·39

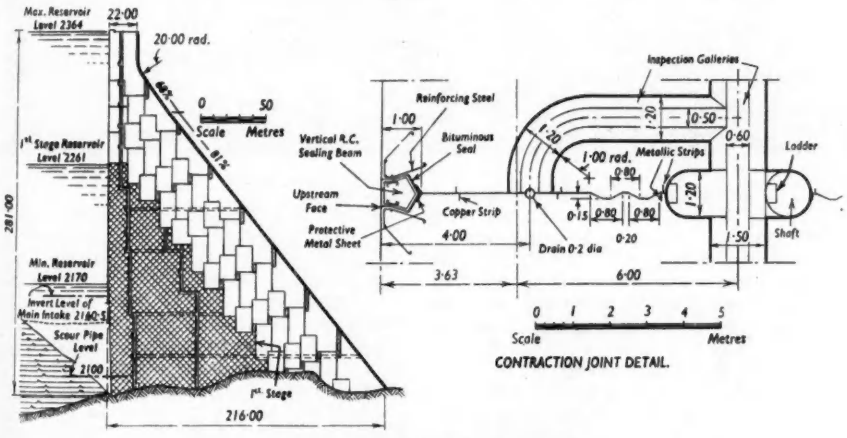


Fig. 5—Details of Grande Dixence Dam

French Locomotive Experiences

By EDWARD H. LIVESAY

(*Continued from page 524, April 9th*)

No. VI—LILLE/PARIS, 4–8–2, FOUR-CYLINDER COMPOUND LOCOMOTIVE No. 241–P33

THE reader may remember that Part II of Article II covered a run made from Paris to Lille on the fine 4–6–4 de Casos compound "U1," which, as the account acknowledged, made such an impression on me that it might well have turned out the return journey to Paris on the same day could scarcely be anything but in the nature of an anti-climax, no matter what type of locomotive was concerned. So I myself thought when looking round No. 241–P33 in La Delivrance yard at Lille during the afternoon, though I could not but be impressed by the size and obvious latent power of the engine. But what I experienced during the evening run back to Paris, one of the most unforgettable of the whole series, showed that this very superficial judgment was altogether wrong, the trip proving just as fascinating as that of the morning, and the engine equally so. If any locomotive could displace "U1" in my regard it would undoubtedly be P33; it is well worthy of a detailed survey.

The "P" class of engines had its genesis about twenty years ago on the P.L.M. line, when the increasing weight of the trains on that system showed that the six-coupled "Pacifics" handling them at that time were becoming overloaded. Accordingly, some experimental running was done with 2–8–2 machines, which proved that high-speed running was not incompatible with comparatively small-wheeled eight-coupled engines, so a series of 4–8–2 locomotives was built with 5ft 10½in wheels, which proved very successful. But the "Pacifics," with 6ft 6in wheels, still had advantages at high speed over the easier sections of the line, so it was decided to combine the good points of both types in 4–8–2s with 6ft 6in wheels, and the "241 C" class was the result; designed by Monsieur Vallantin, they demonstrated conclusively the correctness of both plan and aim. In the course of time, however, extensive electrification of the P.L.M. rendered the steam locomotives on that line more or less redundant and they were transferred to the northern and eastern regions, where they have done admirable work for several years under the "P" classification. In 1949–51, thirty-five more of the class were built with certain minor modifications and improvements, numbered P1/35, and this article deals with one of the last to appear, No. 241–P33. This class is therefore even more recent than the "R," "S" and "U" "Hudsons," and is presumably the last group of express locomotives to be built in France; they, too, will have no successors.

The chief features and dimensions are as follows. The h.p. cylinders are inside the frames, and lie between the first and second coupled axles; they are 17·7in diameter and 26in stroke. The l.p. cylinders 26·3in diameter and 27·6in stroke, the ratio between the two pairs being 1/2·6. The valves (piston) have a diameter of 9·5in h.p. and 14·2in l.p.; their travel is 5·4in h.p. and 7·9in l.p., and they have inside and outside admission respectively. Independent control of the two sets of gear is not allowed for on these engines, as is usually the case on Chapelon machines, any more than it is on "U1"; this arrangement seems to have been finally discarded on French locomotives. The connection between the h.p. and l.p. valve gear gives the following ratios of travel, which, while not variable as to each other, give a satisfactory distribution over the whole expansion range :—H.p., 20, 30, 40, 50, 60, 70, 75 per cent; l.p., 29, 44, 56, 66, 75, 83, 86 per cent.

The method of driving the two sets of valve gear is interesting, and in one or two respects unique. The l.p. valves are driven, as is usual with Walschaerts gear, from a return crank on the second pair of driving wheels; the inside h.p. valves are worked as follows :—The connection of radius rod and combination lever is made through the pin of a pendulum lever suspended from a cross shaft from which another pendulum lever transmits motion by a horizontal rod to a pin on the upper extremity of the h.p. combination lever. The outside link therefore actuates both inside and outside valve spindles, and to this point the arrangement is much the same as that found on the "Hudson" "U1." But provision for lead is different; in this case, on P33, the lead for the l.p. valves is taken from the crosshead in the usual way, but for the h.p. cylinders (inside) it is taken from the tail-rod, which is provided with a light crosshead and guide for this purpose. It is a neat and compact arrangement, which obviates difficulties that might arise from the position of the h.p. cylinders, midway between two driving axles. All the valve spindles are provided with guides cast integrally with the steam chest covers, and all the mechanism is amply proportioned though light in weight. To compensate for the different obliquity of the inside and outside cylinders, the adjacent inside and outside cranks are set at an angle of 170deg. 4min. 58sec., but this is not enough to upset the balance. The valve gear of both sets is controlled by one reversing wheel, and live steam can be admitted to both pairs of cylinders at starting.

The distance between the centre lines of the inside cylinders is 19·29in and of the outside 6ft 11·7in. The h.p. connecting-rods are 7ft 2·6in in length, and the l.p. 10ft 10in; the former drive the third coupled axle. The webs of the inside cranks are extended for balancing, and the guide bars are single; the outside cylinder guides are double.

The wheels have the following diameters:—Bogie, 3ft 3½in; driving, 6ft 6½in; trailing truck, 4ft 5½in. Both bogie and trailing trucks are fitted with inclined planes for displacement, which is 3·93in with the bogie, and 3·74in with the truck. The springs are all laminated, those for the coupled axles being equalised; the first, second and third have 1mm side play, and the fourth 5mm; the flanges of the second, third and fourth are reduced in thickness by 10mm. The journals are lubricated by oil wells with spring pads, except those of the driving axles, which are lubricated by a Wakefield pump, together with the guides. The journals of the first, second and fourth coupled axles are 10·63in long by 8·66in in diameter; the third is 9·84in long by 8·66in diameter. The inside connecting-rod big-ends are 4·45in by 7·48in diameter, and the outside 4·92in by 5·51in diameter.

The boiler, built in three rings, has outside

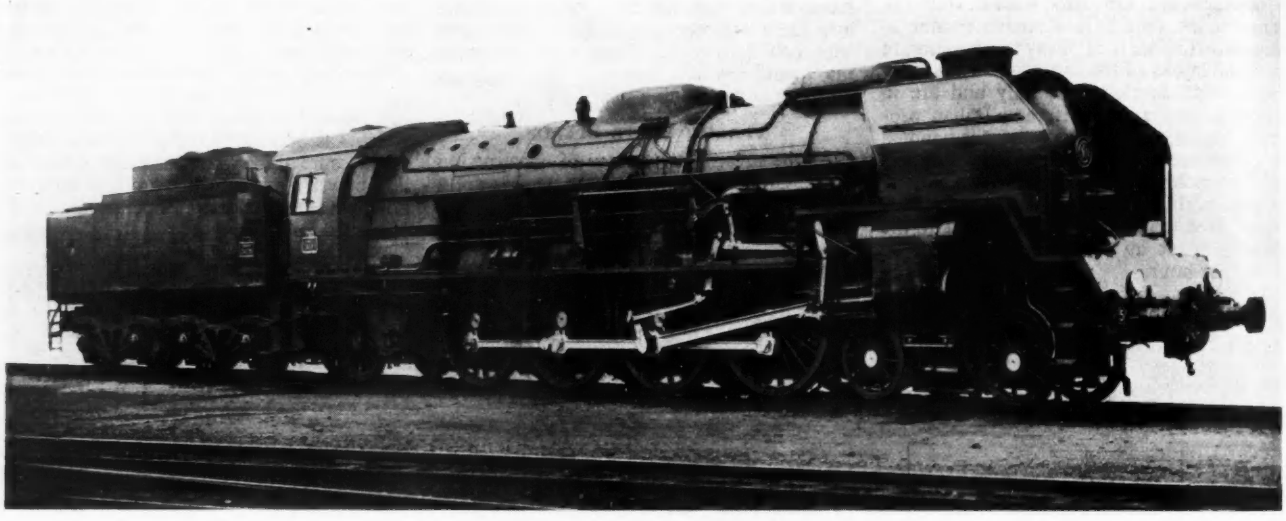


Fig. 35—Four-Cylinder Compound 4-8-2 Express Locomotive

diameters of 5ft 11½in and 6ft 6½in, and is 25ft 10in in length. The centre line is 9ft 7in above the rails. The length of the inside firebox is 8ft 1in, and the breadth 6ft 6¾in, both dimensions at the bottom. The grate area is 53 square feet. The tubes are 19ft 7¾in in length, 141 in number ; the flues number thirty-three and the superheater tubes are 1·38in in diameter outside. The heating surface is :

	Square feet
Firebox	296
Tubes and flues (inside)	2373
Superheater	978
Total	3647

The working pressure is 291 lb (20 hpz).

The tubes are all plain, and the firebox is of copper ; the inclined grate has the front section fitted with hand-operated drop bars. The firedoor is hinged horizontally at its top and swings inwards, and is balanced so that it shuts automatically if there should be a rush of steam from a burst tube or other cause ; the stoking is mechanical. The Westinghouse compound pump is placed on the running plate in front of the smokebox, and the sandbox is on top of the boiler. The Flaman tachygraph, besides recording times, speeds and stops, indicates the pressure in the train-heating pipe, and if a signal has been overrun without the push button in the cab being pressed by the driver. The weights are : Bogie, 30·25 tons ; driving axles each 20·4 tons, total 82 tons adhesive ; trailing truck, 19·5 tons ; total, 131·75 tons

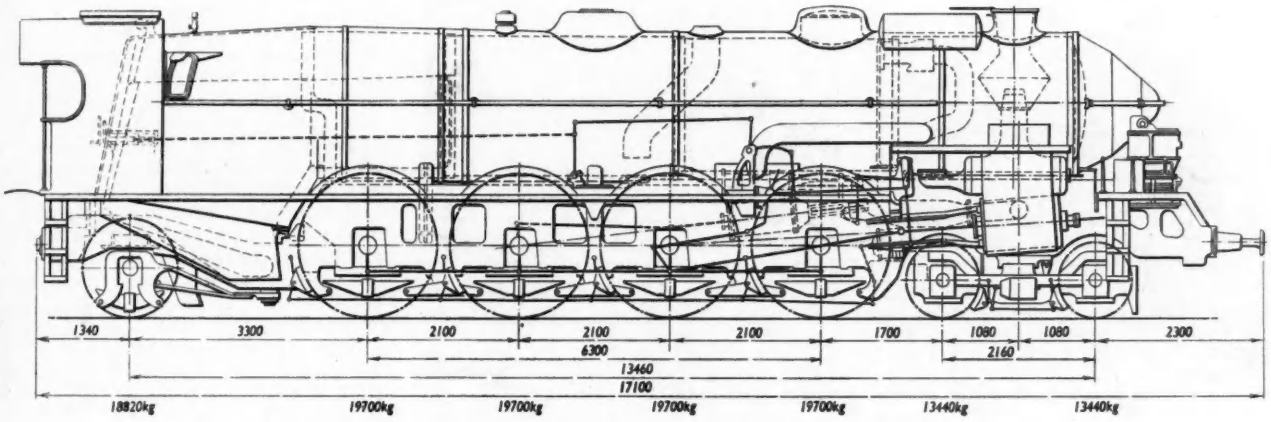


Fig. 36—Leading Dimensions and Weights of Four-Cylinder 2-8-2 Compound Locomotive

The tender is of the standard S.N.C.F. type, carrying 9 tons of coal and 7700 gallons of water ; it weighs 70 tons, the total weight of engine and tender being therefore 201·75 tons.

Fig. 36 shows in outline this type of engine as originally built with Lemaitre blast pipe and conical extension over the smokebox door to create an updraught past the chimney. A Kylchap double blast pipe is now used and the standard side plates, as shown in Fig. 35. Apart from these details, in substance the design remains much as when it first appeared twenty years ago.*

My experience in the cab of No. 241–P33 was with train 338, running between Lille and Paris, leaving the former station at 6 p.m. With Monsieur Leseigneur driving, and the regular mecanicien, Stalin, standing by, chauffeur Giroux and inspecteur Fillon carrying out their respective duties, we left promptly O.T., the engine naturally making nothing of the comparatively light load, 580 tons gross, a mere bagatelle for such a powerful engine—two more coaches were to be added at Arras. Acceleration was correspondingly rapid, despite 3 miles of 1 in 200, which, as the profile† (Fig. 37) shows, begin almost at the end of the platform. The cut-off was 40 per cent h.p., and 56 per cent l.p and the respective h.p. and l.p. steam chest pressures 250 lb and 52 lb. Giroux smilingly waved me to his seat, and for once the invitation appealed to me, so I accepted ; I had already been working practically a twelve-hour day, what with the run from Paris on " U1," a two-hour lunch, La Delivrance shops, to say nothing of copious refreshment, and so on, with the natural result that sitting down somehow seemed more attractive than standing up. But a very brief spell in Giroux's rightful station showed it to be unsuitable ; the day was hot, and so was that sheltered corner of the cab. I immediately felt drowsy, which would never do if I were to make any worth-while notes of the performance of this outstanding engine, so I assumed the vertical, remaining upright the rest of the way to Paris. It was far nicer to travel with my head out in the cool slip-stream rushing past the cab door than to sit cooped up in the corner of the cab, from which in any case I could see very little, and writing was impossible—I never can do this in a cab sitting down, the result being practically unreadable.

The great 4000 h.p. engine was making nothing of the load, of course ; once over the top of the climb from Lille and descending the other side at 1 in 200 through Wattignies, the l.p. cylinders became purely ornamental, and even the h.p. cylinders were not called upon to much more than loaf all the way to Douai. The speed was high, though unfortunately limited to 75 m.p.h., and the riding simply perfect—I have never ridden on a more beautifully behaved engine. It was running like a sewing machine—yes, I know I have used that simile before, but it is a pretty good one, and I shall probably use it again when describing the action of French locomotives, and fairly often ! There was not a single sound from anything indicative of lack of adjustment or leakage ; the impressive machine rushed through the cool air of this lovely summer evening like—well, like a four-cylinder French locomotive—I cannot think of any other appropriate comparison ! My notebook says " Perfect ! " The word is underlined and followed by a note of exclamation, and when I see that, though it be months after the event it chronicles took place, I know it really was so, and can safely enthuse over it. It was as good in every way, if not better, than the behaviour of " U1 " had been earlier in the day—I cannot put it more emphatically than that.

Douai, and a vignette of " the daily round, the common task," as I saw it on the S.N.C.F. and enjoyed. Running into the station, halfway along the platform, suddenly a rumbling explosion of strong language burst from Leseigneur, which continued until he brought the train to a somewhat emphatic stop—what could be the matter ? Flinging himself out of the cab down on to the platform, he strode quickly back to where a big truck piled with mailbags stood beside the mail van, and immediately began giving the panic-stricken wight in charge of it such an angry " bawling-out " that he didn't know which way to look, and was frightened into touching his cap first with one hand, then with the other, even maybe simultaneously. I gathered that the train had to stop with the mail van opposite the truck, to facilitate quick loading, but that the truck had been wrongly " spotted "—hence the explosion. The incident underlined several things noticed on the S.N.C.F.—method, quick action, discipline and respect for authority, none of which have been too common on British Railways in my recent experience, and also that my snap judgment passed on " mecanicien Duterre " in the cab of the " Golden 'Le Fleche d'Or " *en route* from Calais to Paris had been correct—" When he said something, he was listened to and obeyed." He certainly was at Douai !

The stop had been made at 6.28 ; we were away again at 6.30 short and quick, but probably not short enough for that wretched porter, who must have wished it had not been made at all. The profile (Fig. 37) shows we were faced by a long and heavy climb, the line rising almost continuously for 25 miles to the Achiet summit. No. 241–P33 treated it with contempt, the Arras stop, a little over halfway up, being made at 6.51—15 miles in 21 min start to stop, climbing most of the way at 1 in 250, with 580 tons—nothing spectacular, but decidedly worth mentioning. There had been a compulsory brake test nearing Arras, after a whistle warning. The train left at 6.57 after two coaches had been added, bringing the gross load up to about 670 tons, which was hustled up 10 miles of mostly 1 in 200 to the Achiet summit at a speed that never fell below 50 m.p.h. Leseigneur was still disturbed about something, just what, naturally, I did not know. I felt sure, however, that whatever he said was to the point and that every one concerned would pay attention to it.

All the heavy climbing was behind us now ; it was non-stop to Paris, 105 miles, with only the Survilliers bank to give any concern

* For some of these dimensions, and for Fig. 36 I am indebted to *The Locomotive*.—E.H.L.

† The profile of the Longeau/Paris section will be found in Article No. I, Part II, and Article No. II, Part II.

short of the Gare du Nord, and that was not likely to bother No. 241–P33. The outlook was very prairie-like—a wide-spreading plain of great wheat fields with the grain in stook, bisected by straight, poplar-lined roads, unfenced, under a sun setting in pink and gold beneath a turquoise sky. Yes, very Manitoba-like. My attention was divided between this familiar prospect and the beautiful engine, with its equally beautiful action, rushing smoothly along at 75 m.p.h. with its 670-ton load to the musical diapason of its deep, soft exhaust. It all delighted me. I could not recall any experience quite like it ; I felt only France could provide it. At any rate, only France has, in all my 50,000 miles of footplate travel. My thoughts, thus stimulated, went back to another locomotive experience, which, fortunately for my thesis, was described in THE ENGINEER recently (December 5, 1952), and I could not help laughing to myself at the complete

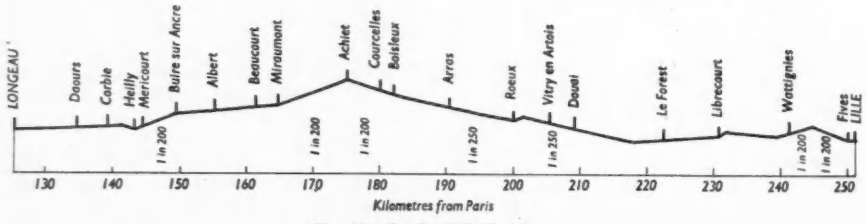


Fig. 37—Profile Lille/Longeau

contrast. I refer to C.N.R. No. 6200, 4–8–4, taking the "Inter-City Ltd." from Toronto to Montreal, and the way it was done. It is almost impossible to overstress the difference in the behaviour of No. 6200 and P33. The roaring, racking, hammering, pounding action of the one, emphasising over very mile the inherent crudity of the big two-cylindered "basic design" locomotive, tearing both itself and the track to pieces, and the smooth, easy, quiet, sympathetic conduct of the multi-cylinder machine, doing its heavy work with the very minimum of fuss, and the least possible stress and strain on everything concerned—no contrast could well be more complete or striking. That 333-mile journey from Toronto to Montreal on No. 6200 was both interesting and enjoyable—to a locomotive enthusiast and a lunatic, the terms being sometimes synonymous—but was really in the nature of an endurance test—I wondered which would crack up first, the engine or me—only Providence ordaining that it was neither. In comparison, this run on P33 from Lille to Paris was a peaceful pleasure trip, and I could easily imagine myself wishing it were twice as long. I do think French engineers have brought the steam locomotive to the highest point of perfection it will ever reach, and it is sad to have to acknowledge that its day, not only in France, but in other countries, too, is nearly over. When I think of "U1" and "P33" I am forced to agree with the poet—I forget which one, and he certainly was not rhapsodising over locomotives !—when he lamented, "Taken for all in all, we ne'er shall look upon their like again !" My only comfort is that I *have* looked upon them, and, moreover, ridden on them, and that I intend to repeat the treatment in the near future. The prospect is a very real consolation !

It was easy going all the way down from Achiet, through Beaucourt, Albert, Mericourt, to Longueau ; everyone and the engine could relax, and did so ; the l.p. cylinders went very nearly out of action at times, a typical reading of the steam chest gauges being 9/2. Giroux moderated the efforts of the stoker engine, keeping the needle of the pressure gauge near the blowing-off point at all times, yet the valves never actually lifted once. Near Beaucourt—though I may be wrong—my attention was directed to the Canadian War Memorial standing up against the skyline, and once more I had to explain that I was only Canadian by adoption, not birth, and was emphatically English. It seemed that Leseigneur drove British Royalty when they came over for the unveiling of this memorial, and again when Their Majesties visited France in 1938. In fact, he only drives for love of the job, and for important people—such as myself.

Passing through Longueau I was on familiar ground again, several runs having taken me over these metals. Near Boves, P33 began to dance a little, though, needless to say, it was not the engine's fault ; the track was due for relaying. The action was really quite pleasant ; it was light, springy, in no way objectionable, and hardly the kind I should have expected from this big machine ; the footplate merely swayed and bounced a little. Further along, we took the "wrong" track, as had been done before with the "Fleche d'Or," the speed coming right down to 10 m.p.h. for a mile or two, speeding up again at La Faloise on the long rise to the Gannes summit. That inwardly swinging balanced firedoor—a good arrangement. I watched the coal, nice, screened stuff, moving slowly on to the shelf below it from the conveyor, to be suddenly caught up and whirled to a fiery death in the raging furnace, and it took me back to Canada, where I had first seen a mechanical stoker in operation.

Clermont was passed non-stop at 8.26, "when the evening sun was low and shadows lengthened." It was gloriously refreshing to lean out from the cab and feel the rush of cool air after the heat of the day. I admit beginning to feel a trifle tired, and that I had not taken quite as many notes as I should—up at 6 a.m., leaving Asnières at 7 ; "U1" ex-Gare du Nord at 8 ; the unforgettable run to Lille, followed by an unforgettable luncheon ; the tour of La Delivrance ; plentiful refreshment, and now the wonderful trip back to Paris on P33—a very full programme, and it was taking its toll. Once I had fallen asleep on my feet, waking with a jerk to find the crew looking at me with friendly grins ; my eyelids felt like lead. Naturally, I was sleepy—anyone would be, lulled by the easy, steamer-like rolling of this splendid engine, and it had been a long, hot day. Creil, 8.35, and a slight slowing through the station ; then up the long Survilliers bank through the Forest of Chantilly in the gathering dusk, at a speed that never fell below 60 m.p.h., and this with 670 tons. I would love to see this engine really extended, say, with 750 tons, unhampered by restrictions of any sort—the result would be worth writing about !

Over the top, it was all downhill to Paris, which was not far away, and the speed was checked to 55 m.p.h. or so as we drifted down to St. Denis. There was no need to rush things, as we were a trifle ahead of time, and in France trains are not allowed to arrive more than 3 min early. The electric light was switched on, and the cab filled with a mellow glow, so ample that the gauges could easily be read from the back of the cab. Why cannot we have electric light on engines in England—are we as "broke" as all that ? I do not believe it ; it is just a bad habit, "making do," as our fathers did. The speed was allowed to pick up a little nearing St. Denis, to 65 m.p.h., slowing again on the rise into the Gare du Nord, where P33 came to a stand at 9.11 p.m., 1 min early. The 115 miles from Arras had been covered in 134 min, at an average of 51·5 m.p.h. Nothing out of the way, of course, but the load had been heavy, most of the distance restricted to 75 m.p.h., and no effort whatever had been made to extend the engine—the schedule had merely been kept, and was not a difficult one. It had been a very pleasant run, indeed, and everybody had been very kind to me ; the day stands out inasmuch that I had made the acquaintance of two of the very finest locomotives in existence, I am convinced. I have no criticism to make—no fault whatever to find—the engine was in perfect running condition.

As usual, the three of us straightway proceeded to "La Maison Blanche" for refreshment, which we considered we had earned and needed. Later, my good friends escorted me across the road to a bus stop, where I was told to await the arrival of a No. 26 for the Gare St. Lazare. It seemed rather a long time coming, so I appealed to a bystander in my best French—Heaven forgive me the adjective—for reassurance, and was much relieved to find he was a Cook's man, also going to the Gare St. Lazare, so we proceeded thither, cementing acquaintance *en route* at an attractive cafe—this was becoming a habit. Finally, I had to point out that if I were to find my train for Asnières it was essential at any rate that I should *see* it, but my friend assured me I was mistaken—all that was necessary was that *he* should see it ; he knew where to find it, and was going to take me to it, so that was all right. He did so, and I got in, sinking back on a comfortable seat, drawing a deep breath of relief—positively my troubles for the day were over. Not so—I fell asleep at once, waking in panic at Bois-Colombes, a station beyond Asnières, only having just time to escape from the coach before the doors shut. It seemed too risky to take train back to Asnières ; I should probably fall asleep again and find myself back at the Gare St. Lazare ; my eyes simply would not keep open. So I walked back, guided by the railway, along that fascinating Rue Henri Barbusse, from which I so often watched the traffic, steam, electric, diesel, &c., on "rest" days, reaching the haven where I would be at midnight. I had worked an eighteen-hour day, from which the reader will gather that locomotive experiences on the S.N.C.F. are sometimes garnered the hard way, and are not to be undertaken lightly.

(To be continued)

ASSOCIATION OF PUBLIC LIGHTING ENGINEERS.—The annual conference of the Association of Public Lighting Engineers, 22, Surrey Street, Strand, W.C.2, will be held at Eastbourne from September 14th to 17th next, under the presidency of Mr. L. A. Doxey. The provisional programme provides for papers on "Street Lighting and Road Safety," by W. Robinson ; "Some Unusual Uses of Fluorescent Lamps in Street Lighting," by B. C. Ossitt ; "The Control of Electric Street Lighting," by A. J. Ogle ; and "Research on Two Aspects of Street Lighting : Accident Statistics and Road Surface Characteristics," by A. J. Harris and A. W. Christie. An exhibition of street lighting equipment will be held in conjunction with the conference.

New Kearny Power Station in New Jersey

(By Our American Correspondent)

No. I

The new Kearny generating station of the Public Service Electric and Gas Company at Kearny, New Jersey, which went into full operation at the end of 1953, constitutes a good example of the most advanced current American power station practice. It employs steam conditions of 2350 lb per square inch gauge pressure, 1100 deg. Fah. initial temperature and 1050 deg. Fah. reheat temperature, and its two sets have a net heat rate of 8920 B.Th.U. per kilowatt-hour. The station comprises two semi-outdoor, two-drum water-tube boilers employing the controlled circulation principle and two 145MW tandem-compound, triple-flow reheat turbines operating at a speed of 3600 r.p.m. The two main alternators are hydrogen-cooled, two-pole machines generating three-phase alternating current at 20kV and 60 c/s.

THE Public Service Electric and Gas Company serves one of the more important industrial regions of the United States. Its supply operating area extends diagonally across the State of New Jersey in a long narrow band from the New York state line to a point 10 miles below Camden. In this strip, 112 miles in length by 7 to 21 miles in width and approximately 1500 square miles in area, reside 3,500,000 people, or 80 per cent of the population of New Jersey. With the completion of the new Kearny generating station, the total capacity of the Public Service electric system has been increased to 1910MW. The major portion of the power produced by the company is transmitted from its five generating stations over a 132kV transmission grid which consists of a ring main surrounding the heavy industrial area in the northern part of the State with an extension to the cities of Trenton and Camden in the south. From fourteen switching stations situated on the 132kV grid, transmission at 26kV delivers energy to 138 substations. The Public Service system is interconnected with neighbouring companies at voltages ranging from 26kV to 220kV, thus becoming a part of an interconnected electric supply system having an installed capacity of more than 7400MW.

The new Kearny generating station (Fig. 1) is situated adjacent to the original Kearny station on the Hackensack River, which was placed in operation in 1925 and 1926. The earlier installation has a capacity of 334MW, and the combined generating capacity at Kearny is now 624MW. The considerable progress which has been made in the generation of electricity by the use of steam in the last quarter of a century becomes apparent by comparing the new generating units with those in the old station. The turbo-generators have trebled in size. The steam pressure is almost seven times as great and the steam temperature has been increased by almost 50 per cent. It now requires only half as much coal to produce a unit of electricity as it did in 1926.

Civil Engineering Work

The structure containing the new generating units extends north from the north end of the old station, on ground which has been filled to grade. The elevation of bedrock at the site varies from approximately 35ft below ground level at the east or river side of the station to approximately 60ft below ground level at the west side. The condenser circulating water intake screen well for the two new turbo-generators is situated on the centre line between the sets (Fig. 3). A new unloading dock was built between the existing dock of the power station and the screen well. It is approximately 80ft long and 40ft wide, with its platform situated at approximately mean tide level. A concrete face wall retains the fill between the platform level and the finished grade. Stability of the dock is obtained by batter piles and by a rip-rap dyke below the platform level.

The principal structure is the power station building proper, which includes the boiler-house, the turbine room, the electrical bay and the pulveriser room. Except for a new test department and a shower and locker room, all service facilities have been provided for in the old station. The structure containing the two generating sets has overall dimensions of only 190ft by 274ft (Fig. 4). Thus, the use of semi-outdoor boilers has not only reduced the necessary capacity of the station ventilating system, but also has resulted in a considerable saving in building cost through a reduction in the area of the exterior walls, the floors, and the roof. The power station structures and practically all of the switchyard conduit lines are supported on piles of various lengths. The foundations for other equipment not connected with the building are supported on wood piles cut off just above mean low water level or below it in the case of deep foundations. These timber piles averaged 25ft to 30ft in length east of the building and 50ft to 55ft in the transformer yard. When it was found that on account of the weight of the generating station building wood piles could not be used, it was decided to employ 12in, 53·5 lb per foot steel H-piles, tests having indicated that, with a cathodic protection system, there would be no danger of corrosion at the site. The steel piles vary in length from 30ft to 60ft and carry a design load of 54 tons per pile. The piles were capped by a concrete mat 2ft 6in thick under the floor slab and 5ft 9in thick under the building columns and turbine foundations. Fly-ash concrete was used for practically all work, resulting in a mixture having a minimum strength of 3500 lb per square inch at twenty-eight days.

At an early stage in the design of the station building it was realised that the compromises necessary to integrate the new structure with the old one could not be justified, and it was then decided to design the new plant, as far as practicable, as an altogether new generating station. Thus, the treatment of the new building is simple, with strong horizontal lines resulting from continuous rows of sash and glass block.

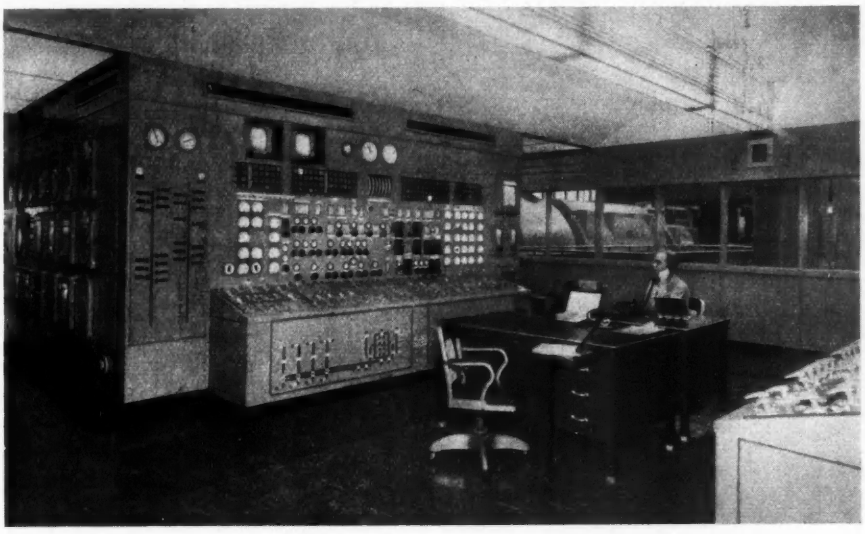


Fig. 2—Control Room of New Kearny Power Station

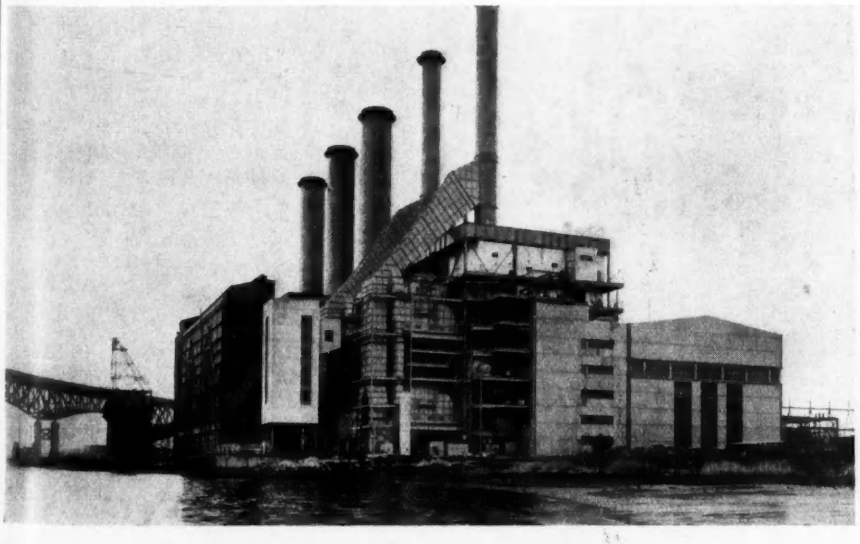


Fig. 1—New Kearny Power Station seen from the Hackensack River

NEW KEARNY POWER STATION, NEW JERSEY

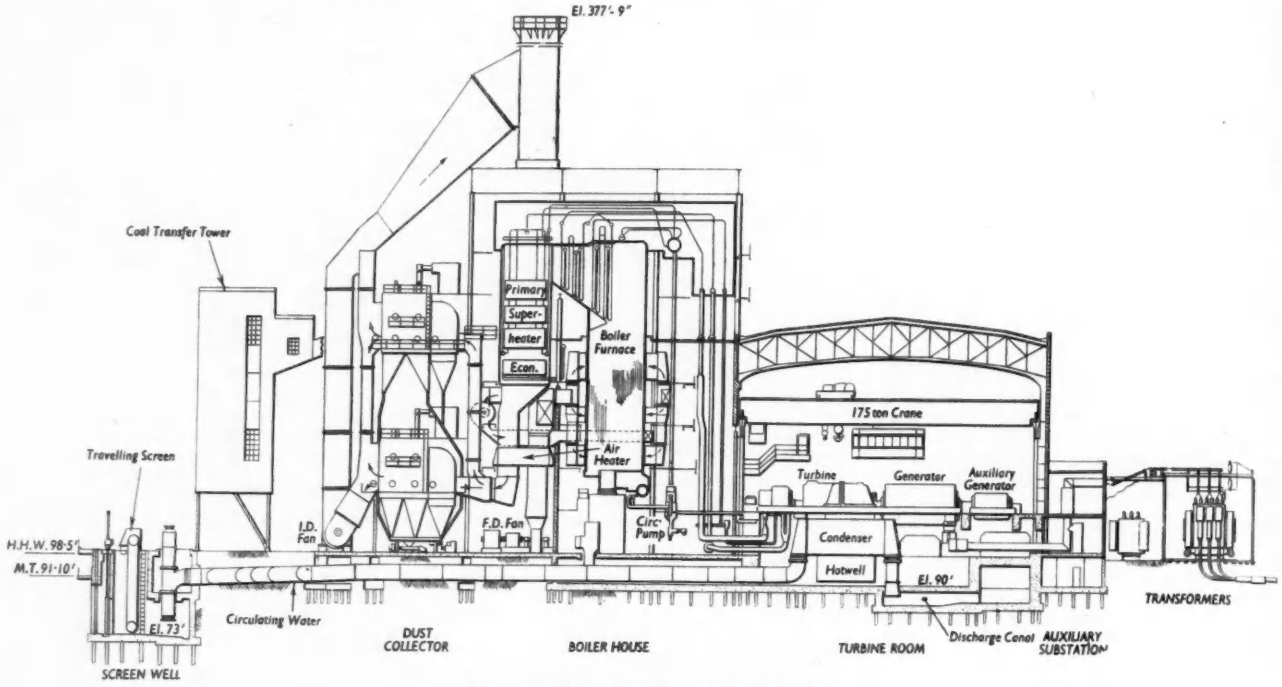


Fig. 3—Sectional Elevation of Power Station

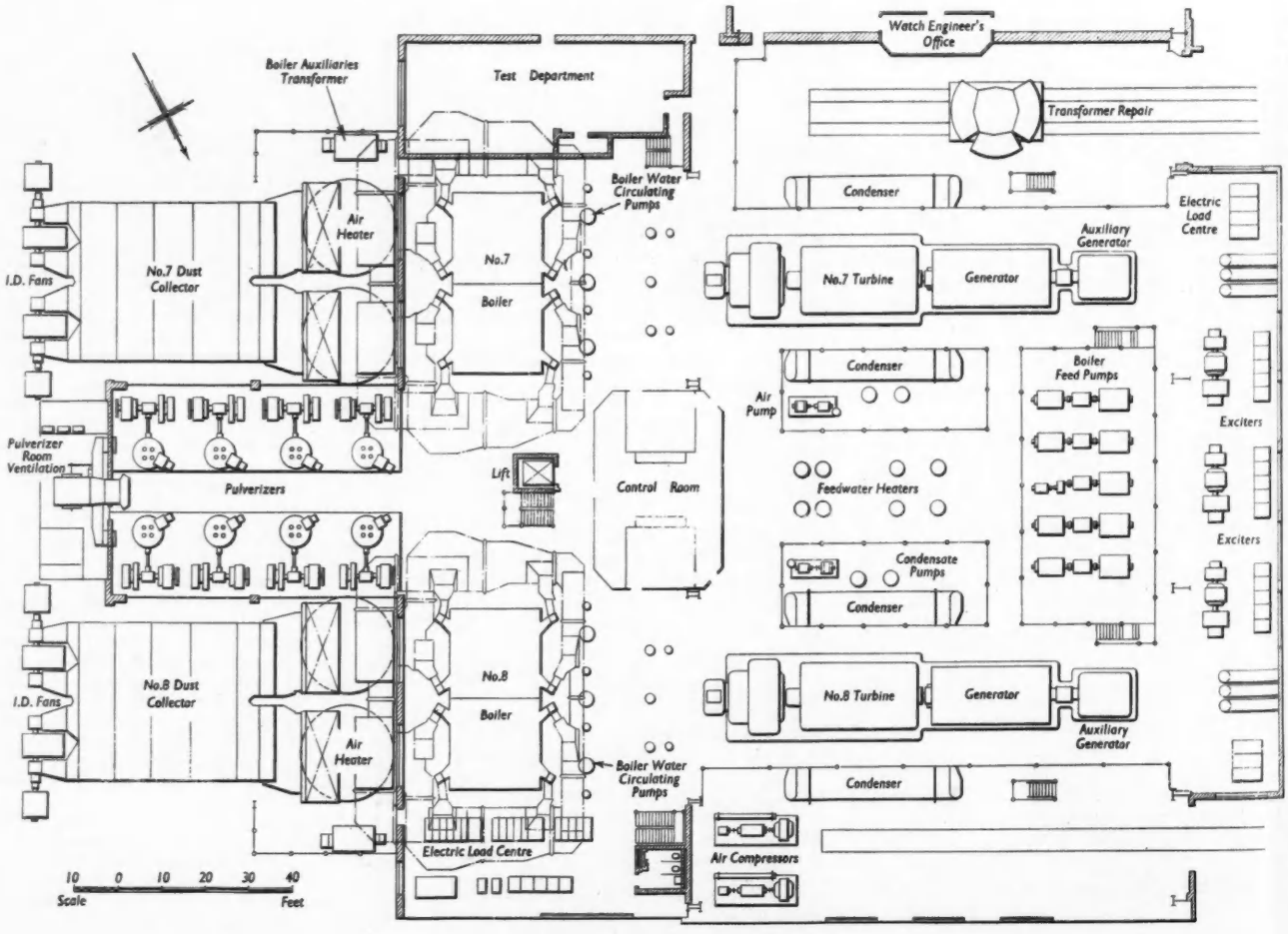


Fig. 4—Floor Plan of Power Station

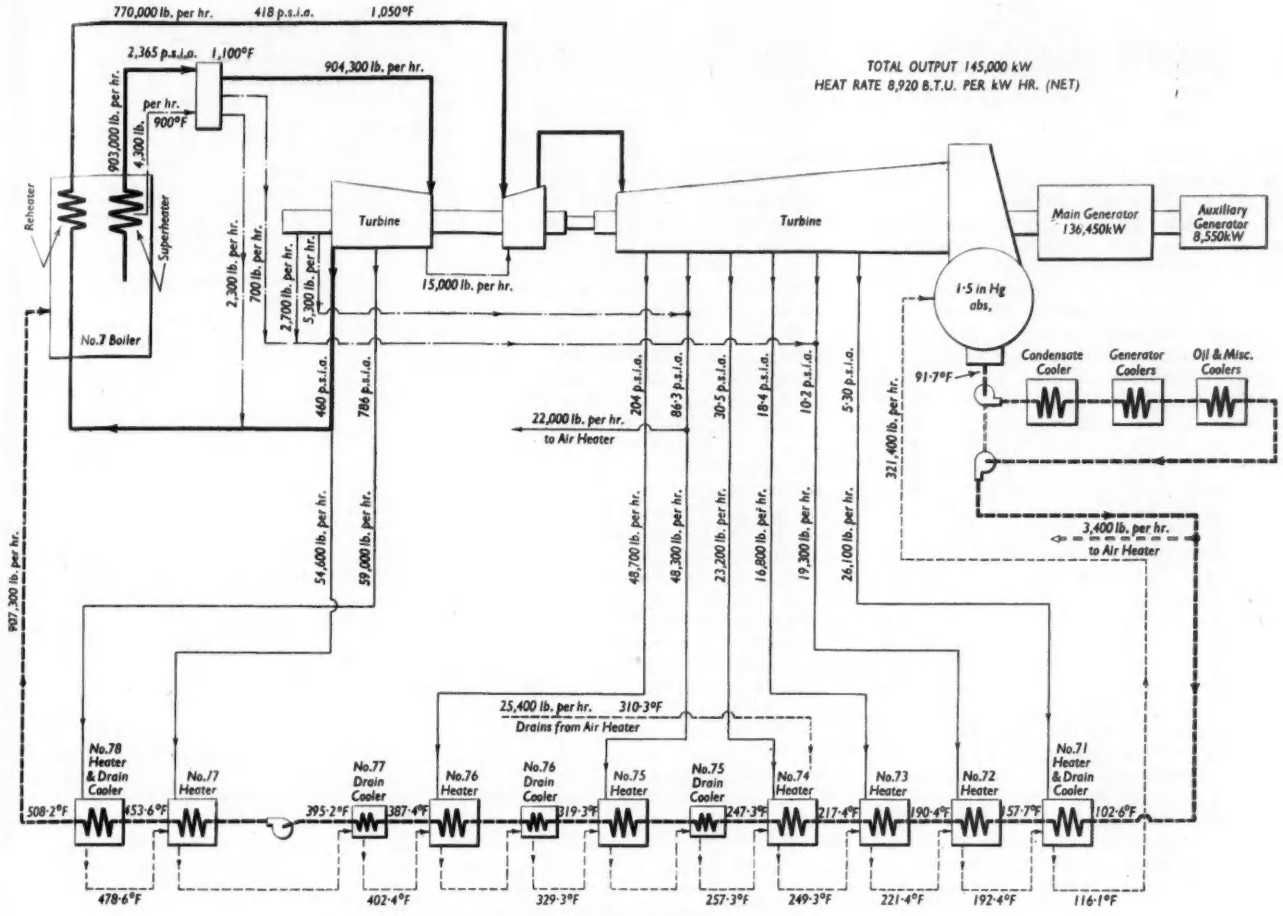


Fig. 5—Steam and Feed Water Flow Diagram, New Kearny Power Station

The building is faced with grey brick, trimmed with limestone, and all the window frames are aluminium. The new turbine room is separated from the existing turbine room by a fire wall into which is built the watch engineer's office, thus providing an easy view of both stations. The bays of the building structural steelwork are 45ft long, permitting the boilers to be set in between two lines of columns. The turbine room roof is supported by roof trusses spaced at 22ft 6in centres, with purlins connecting the individual trusses. The floor construction consists, in general, of reinforced concrete slabs supported on steel beams. All of the exterior platforms around the boilers and most of the interior platforms are of steel grating. The roofs of the turbine room and miscellaneous structures above the main roof are built up of precast ribbed concrete units 2ft wide. Other parts of the roof structure consist of poured concrete slabs. The interior finish of the various areas of the building was selected to require a minimum of maintenance, and all of the work areas are faced with glazed tile. The ceiling of the test department and the turbine room have perforated mineral acoustical tile, which is 1in thick and has been assembled in 12in by 24in units.

Each boiler is served by a steel chimney, 14ft 5in in diameter and 144ft 5½in high. The chimneys are lined with a 3in layer of "Gunite" reinforced with 10 gauge welded steel wire fabric.

Steam and Feed Water Flow

The new power station has, for its principal equipment, two turbo-generators and two boilers arranged in the form of two units. The accompanying diagram, Fig. 5, shows the flow of steam and feed water in one of these units. The entire plant is operated from a control room, Fig. 2, situated at operating floor level in the centre of the square formed by the four major items of equipment. The new units are operated as a separate station with practically no ties, electrically or mechanically, with the old station. The boilers are close to the turbines, hence the steam leads are short. The coal pulverisers are placed alongside and between the boilers and are enclosed in a separate ventilated room. The feeders of all pulverisers are accessible from one platform. The new Kearny generating station has been designed for two-level operation, with the two levels 15ft apart. The building volume has been significantly reduced from that required for a complete enclosure, and the saving in first cost due to this reduction is estimated at 300,000 dollars. All parts of the boilers are out-of-doors, except the burner areas and the bottoms of the furnaces. The top drum and the three steam headers of each boiler are enclosed in the boiler casing.

The feed water heating cycle includes eight stages of heating with six heaters per unit before the boiler feed pumps. At full load the pumping temperature is 395 deg. Fah. Each boiler unit is equipped with two Worthington horizontal, nine-stage centrifugal feed pumps, each having a capacity of 1380 U.S. gallons per minute at 6650ft total head at a full-load speed of 3465 r.p.m. The pumps are driven by 3000 h.p. induction motors through variable-speed hydraulic couplings made by the American Blower Corporation. A fifth pump has been installed to act as a standby set. To provide a cold water emergency supply for the feed pumps, in the event of the loss of a condensate booster pump, one electrical feed for each set of pumps has been provided, with the result that a failure of either pump stops both the condensate booster pump and its associated boiler feed pump, leaving the remaining set of pumps operating. The condensate section of the condensate booster pump takes its suction from the storage hotwell of the condenser. A spare feed pump can be paired with any of the four condensate booster pumps of the two units. There is a cold water connection from the head tank to the feed pump suction, which is effective at pumping temperatures below 275 deg. Fah.

(To be concluded)

Squirrel-Cage Induction Motors for the Chemical Industry

We learn that the English Electric Company, Ltd., Stafford, is now manufacturing a range of squirrel-cage induction motors specially designed for operation in the corrosive but non-explosive atmospheres found in installations such as chemical plants, plating shops, gasworks, coke plants, salt works, and oil refineries. The motors are made to British Standard dimensions and are available in outputs up to 25 h.p. Although they are similar in appearance to the normal English Electric class "LY," totally enclosed, fan-cooled machines, the new motors incorporate many details designed to resist the corrosion caused, for example, by excessive humidity, salt air and sulphur dioxide fumes. A moulded plastic fan, mounted on the non-driving end of the shaft, cools the motor by blowing external air along axial cooling fins cast integral with the motor frame. The fan is made from phenol formaldehyde, and durability and fatigue tests have been carried out to prove the suitability of this material and also the special method of fixing the fan on the shaft. Polyvinyl-acetal-covered wire is used for the stator winding. The windings are impregnated with phenolic insulating varnish by dipping and baking them four times in an automatic heat-controlled continuous oven; this process has been found to produce a finished winding capable of high resistance to corrosive chemicals.

Wherever possible, cast iron is used for components forming the external surfaces of the motors. The cowl over the fan is also made of cast iron instead of pressed steel, and all external surfaces of the stator and the fan cowl are finished with a special protective paint. The rating plate is made from polyvinyl chloride to ensure that it is not obliterated by corrosion.

Conference on Coal Gasification.—An international conference on the complete gasification of coal is to be held at Liège from May 3rd to 8th. It is being organised by the Institut National de l'Industrie Charbonnière (Inichar), 7, Boulevard Frere-Orban, Liège.

Institution of Naval Architects

ANNUAL SPRING MEETING

No. I

THE annual spring meeting of the Institution of Naval Architects opened in the "Wellington," the headquarters ship of the Honourable Company of Master Mariners, Victoria Embankment, London, on the morning of Wednesday, April 7th, with Viscount Runciman of Doxford, the president, in the chair.

The secretary presented the annual report of the Council for 1953, in which it was recorded that H.R.H. The Prince of the Netherlands had accepted an invitation to become an Honorary Member ; and that, in recognition of his services as Treasurer, Instructor Rear-Admiral Sir Arthur E. Hall, K.B.E., C.B., had been elected to be an Honorary Vice-President. A small increase in membership of fifty-seven was noted to bring the total up to 3659.

Two premiums were awarded for 1953, namely, to Mr. J. L. Bartlett, C.B.E., R.C.N.C., for his paper "The Motions of an Aircraft Carrier at Sea in Relation to the Operation of Naval Aircraft" ; and to Mr. R. T. Shiells, B.Sc., for his paper "A Skin Friction Determination Using Wall-Sided Models of Great Draught." Awards of the National Certificates in Naval Architecture were recorded and also that the Duke of Northumberland Prize had been awarded to Mr. J. C. Moss, of Birkenhead Technical College, a special prize being awarded to Mr. S. M. Tennant, of Dundee Technical College.

Notes upon the progress of the Southern Joint Branch were included, and also the announcement that a branch of the Institution is now being formally established in Australia. With regard to the work of the Tonnage Measurement Laws Committee, the report stated that although the Committee's proposal was not acceptable, a modified amendment was agreed upon by the Ministry, the General Council of British Shipping, the Shipbuilding Conference, the Institution of Naval Architects, the Institution of Engineers and Shipbuilders in Scotland, the North-East Coast Institution of Engineers and Shipbuilders, and the Institute of Marine Engineers. Details were given of the Amending Bill, which was presented to the House of Commons on January 20, 1954, and received the Royal Assent on March 9th.

Included in the report were brief summaries of the work and programmes of four research organisations, namely, the Ship Division of the National Physical Laboratory, the British Shipbuilding Research Association, Pametrada, and the British Welding Research Association. The scholarship awards for 1953 were listed and also particulars of the 1954 scholarships.

Presidential Address

After the reading of the report Viscount Runciman gave his presidential address, of which we print the following abstract :

The year 1953 has been a very full and very satisfactory one for this Institution, and a number of things have happened which require special notice. The first is the revision of our by-laws, with special reference perhaps to new By-law 24, which empowers the Council to form branches. The Southern Joint Branch of this Institution and the Institute of Marine Engineers held its inaugural meeting before our last annual meeting here ; that body is flourishing, and one might hope will lead to others like it. However, the most spectacular event in this connection is the formation of the Australian Branch. It is the first under these new powers, and it grew from the initiative of Mr. Cecil Burton in Australia, who had been minded to form a counterpart of this Institution in that great Dominion. He was fortunate in being able to discuss his proposal with Dr. Dorey, as the result of which it was decided to seek to form a branch of this Institution in Australia. A constitution was drawn up and agreed, and was approved by this Council, and the branch has now been established with a provisional body to carry it over until it can hold its first elections, and I think we may look forward with great hope to a very useful future for it.

I had the good fortune a year ago to announce the generous donation that Lord Weir has made, and after long and careful consideration of the best use to which it can be put it has been decided to apply it to the Institution lecture hall and to name that lecture hall after Lord Weir. I think that is a very happy decision, and that the hall, which shows signs of being convenient, commodious and handsome, will be of great service to the Institution.

We take some pride in having made no particular appeal for funds for the provision of this hall. But that does not mean that we are not exceedingly grateful for one or two offers we have already received of gifts for the embellishment of it or for adding to its convenience. In any case, we do feel very great gratitude to those who have made such proposals, and if anybody likes to come along with any further suggestions they will be listened to with appreciation.

You have already heard mention of the Amos Ayre Lecture, and I think that we should go on record, as an Institution, how grateful we are to the Shipbuilding Conference and how very suitable a memorial to Sir Amos Ayre this lecture is likely to be. I am happy to be able to say that we have a promise to deliver the first lecture next year from Sir Robin Rowell.

I would not like this occasion to pass without some reference to tonnage measurement. The annual report tells you what has been accomplished ; but I would like to add how conscious I am myself, not only in this capacity as president, but also in certain other capacities in which I have come up against this problem, of the debt we owe to the persistence, and the refusal to be cast down, of Sir Stanley Goodall.

We had a successful autumn meeting in Holland last year. I am delighted to see here to-day Professor Jaeger, who did so much to ensure the success of that meeting, and welcome others of his countrymen who are with us. We still remember with satisfaction the acceptance by the Prince of the Netherlands of Honorary Membership of this Institution.

It is appropriate that we should have our autumn meeting at Torquay, and fortunate that we shall be able to combine it with the unveiling of the William Froude Memorial.

I must refer again to the preparation of papers and particularly to the question of diagrams. While a diagram is a useful way of presenting facts, I appeal to those who write papers to remember that it is exceedingly expensive to print ; if they could confine themselves in respect of the number of diagrams and exercise even greater ingenuity and lucidity in the wording as well they would save the funds of the Institution.

Perhaps I may mention two of the papers that are to be read at this meeting. One is that by Lieut.-Commander Bathurst on underwater television, a development which unfortunately is usually associated in the public mind with disasters of one sort or another. It is something which has the very greatest value and usefulness, and it is rightly attracting a great deal of public notice. The other is that by Sir Victor Shepheard about the Royal Yacht.

The first paper at the meeting was presented by Sir Victor Shepheard, K.C.B., R.C.N.C., and entitled "Her Majesty's Yacht 'Britannia,'" and an abstract of the paper appears in this issue on page 568.

Discussion

Sir James M. McNeill : Among the facts that require re-emphasis is that this ship was designed to the minimum dimensions. That applies to all designs, particularly to passenger ships, and if we achieve this we have the right answer. There is one test of a design, "Does it look well when it is finished ?" It looks smaller than it really is, and that is a good guide.

In the section of the paper headed "Hull Form," mention is made of the adoption of the semi-bulbous bow. We had good reasons for proposing this and one was that it gave excellent access to the structure and allowed of sound workmanship in an awkward part of the ship ; the forms of the sections, as shown by the diagrams, all combine to make the bow avoid the fault of pounding in head seas. The benefit derived from the adoption of the semi-bulbous bow was about 5 per cent in power at 22 knots, an advantage which disappeared at round about 18 knots.

We have gone back to merchant practice by the adoption of sprinklers and the positioning of oil fuel and water systems and also the arrangement of the sewage tanks. Details are given of the life-saving appliances, and you will notice that rafts have been adopted for some of those. The capacity provided is ample, and I think there is now a case for the adoption of these life rafts in merchant practice ; they might usefully be applied to all passenger ships, particularly those carrying large numbers of passengers.

The early trials enabled us to deal with any local vibration arising, which was extremely small ; the addition of any local stiffening was done in the most economical way, and the final results have justified following such a procedure.

As Sir Victor has indicated, all the technical conditions have been fully met and the ship's performance has justified all our expectations.

Surgeon-Commander Lees : There are two different types of hospital ship : the military hospital ship, whose function is to transport the sick and wounded back to base, where they will be given hospital treatment ; and there is the naval hospital ship, whose function is to serve as a base hospital with the fleet in place of or to augment shore hospital facilities. This ship is the second type of hospital ship, and I doubt whether she would be suitable as a military hospital ship.

The alternative use of the ship as a hospital ship has been considered from the very early stages of design. She will be fully equipped as a hospital with special departments, carrying a surgical specialist and also a

medical specialist, for even in wartime the ordinary medical cases form far the larger percentage of the patients in a naval hospital ship. We are not concerned very much with war casualties, but with the treatment of the sick and also with providing specialist out-patients' consultations for the fleet.

This ship will have a fully equipped clinical laboratory, which will be useful in the investigation of disease, and an X-ray department. The set which we intend to put into the ship will be 200MA, 100kV, which is larger than in any hospital ashore. There is also an ophthalmic department. There has been a certain amount of criticism concerning the smallness of the hospital. For a military hospital ship it would be too small, since it would not be an economical proposition to take only 200 patients for a long sea voyage back to their base. However, as a base hospital I think it is a very useful intermediate size.

With regard to the construction of the ship, the strengthening of the shelter deck aft to take a helicopter is primarily a hospital requirement, the helicopter being useful for transferring patients.

Dr. R. W. L. Gawn : My acquaintance with " Britannia " has been limited to the models and, later, to the trials. Speaking as an experimenter, it is a pleasure to find reference to the wide scope of the tests which now go to improve the design of ships. Formerly the traditional tests were concerned with resistance and propulsion in calm water ; but here we have seaworthiness, cavitation, vibration, air flow and other matters, and I would like to bring out one or two features, by way of amplification.

Fig. 4 shows the cavitation of the propeller. Unfortunately these prints are a little blurred ; however, these pictures were taken with a very fast flash, actually 25 microseconds, and the negatives are clear. If you look carefully you can just detect on the face of each blade near the leading edge and from about half to three-quarters radius a wisp of sheet cavitation. We were rather interested when we examined the propellers in dock after the trials to find that there was slight pitting there, and that was the only part of the blades affected.

Sir Victor has reminded us that the propellers had something to sing about ; but we could have wished that one of them had not been so chirpy, because the ship was due to dock at an early date and something had to be done at short notice. From earlier experience we knew that if we machined the edges to rather a fine thickness we could be pretty sure that we should cure the trouble. We measured the frequencies and the volume of the noise and also estimated the eddying vorticity at the trailing edge ; the figures agreed pretty well, and we decided the approach should be to grade the finish of the edge in order to avoid any excitation of frequencies giving resonance around the periphery of the blade. That has not quite achieved success, but it has gone a long way and we shall look forward to an opportunity of testing the further modification.

In Figs. 7 and 8 there is a wide range of information on ship motion which I suggest has a few general lessons. In Fig. 8, on the left, we have the amplitude for a shallow wave, and you will find the ratio there is a little greater than the amplitude in the steeper wave. That is consistent with results we usually get from such tests on models of other ships, and it does point to some limitation of the linear theory and to the scope for further investigation.

Another matter of interest is the peak amplitude. You will see that it is never much greater than about 20 per cent or so in excess of that of the surface wave, for pitch, and that sort of amplitude ratio and magnification factor is obtained in tests generally. On the other hand, if you examine rolling diagrams you will find the ratio is more like 5/10, which immediately suggests that the damping is extraordinarily heavy in pitch ; but when you work it out you find that there is still plenty of scope for increase of damping and for bringing these peak amplitudes down.

In Fig. 9 you will see that at the speed of 10 knots the hull resistance is roughly proportional to the wave height, but the peak occurs in a wave about 350ft long. If you turn back to Figs. 7 and 8 you will find that the motion of the wave is a good deal less than the peak motion. That occurs in a wave more like 500ft long, and it suggests to me that the phase of the motion is playing an important part here and that that is also a matter for further investigation.

I might explain with that diagram that you measure the resistance at uniform speed in waves, but it is by no means steady ; there is considerable fluctuation, and the curves represent the broad average of the resistance over the length of run in the experiment tank.

Commander (E.) Allen : One thing I would point out is the necessity to design a hospital ship slightly differently from a small ship which just crosses the Channel or makes other rather short journeys. As a hospital ship we must keep steam up when in harbour for quite considerable periods, for we have very heavy loads for the air conditioning for the wards and the electrical load. It is important that in keeping steam up we must not upset maintenance, and consequently must arrange the machinery and design the pipe installations so that we can refit a proportion of the machinery while the remainder is doing its job. That means that the pipe system must be carefully thought out and the necessary valves put in for isolation purposes.

Mr. K. C. Barnaby : Sir Victor states that the " predicted two-node frequency was 116 cycles per minute." A somewhat higher frequency might have been expected from the dimensions of the yacht, and it would be interesting to know if the prediction was confirmed in practice and with the ship in deep water.

It is stated that a semi-bulbous bow was adopted on the suggestion of the builders. While this feature has no doubt contributed to the high performance of the vessel, bulbous bows have the reputation of producing wetter foredecks. The severe, modern profile of the " Britannia " will no doubt evoke criticism from those who prefer the traditional style and they will recall the " Nahlin," also a Clydebank ship and perhaps the most graceful power yacht ever built. Such a comparison would be grossly unfair, however. The new ship will have a yacht tonnage of presumably about 5200 tons, and has to provide for about double the complement per 100 tons and, in addition, a vast number of special rooms. One can also argue that a Royal Yacht should not look too beautiful ; it might crowd more wrong ideas about extravagance into irresponsible heads.

Mr. E. Leslie Champness : I have only one excuse for intervening in this debate, and that is to say that this paper is a most impressive record of the care and thought and scientific solution of all points arising in the design of this vessel, and it epitomises the wide activities and skills of the Royal Corps of Naval Constructors and the builders and engineers.

I hope I may be allowed to say how far from British public opinion and generosity are some of the questions recently heard about the Royal Yacht in what I understand is called " another place." Indeed, I have not the slightest doubt that there are several millions of citizens in this country who, as part of the greatest maritime nation in the world and at the start of a new Elizabethan era, would gladly have considered the gift (apart from public funds) to their Sovereign of a dream yacht as an appreciation of the incalculable value to the nation and to our Commonwealth of the present world tour.

Mr. H. S. Pengelly : In the section of the paper headed " Rudder " it is stated that " The centre of pressure was abaft the rudder axis at all forward speeds and for all rudder angles tested. It was not possible, however, to bring the centre of pressure further forward without unacceptable modification to the stern form." I am very glad it was not possible to bring the centre of pressure further forward. It is a very good thing for a rudder to be slightly underbalanced ; then, if anything goes wrong with the steering gear, the rudder tends to come back to 0 deg. and not to swing round to the full rudder angle. I had experience recently of that in an aircraft carrier. The rudder was overbalanced and swung round and it was most awkward. I would like to see added, if possible, what were the actual torques on trials when the ship was proceeding ahead at 22 knots and astern at 14 knots. I think that would give a good comparison with the model results.

Dr. J. F. Allan : This paper records the research carried out before the construction of the Royal Yacht, and I think it is important to point out that most of these considerations are included in the design of merchant ships to-day.

In particular, the amount of interest that is displayed in the design of superstructures and funnels to improve air flow, especially in the large passenger liners, has become a major activity in one of the wind tunnels at the National Physical Laboratory. The experiments illustrated in Figs. 10, 14 and 15 are interesting, and the solution which has been found, while effective in certain areas, appears to create more violent concentrated jets of air in other areas. That may be necessary ; as has been pointed out, this bridge deck is forced on the designers. It reminds me of the conditions on a cross-Channel ship, where there was a staggering of this proportion ; the back draught was very violent, running round and rising again just behind the bulwark. Is it not possible to obtain a different solution to this problem? And what is the possibility of putting a horizontal plate at a suitable height on the base of the structure at the back of the steps of the deck to intercept the down draught and deflect it sideways and forward ? I think that a satisfactory result might be achieved in that way without creating this very powerful jet which comes right past from the screen.

Concerning the rough water experiments on seaworthiness, a study of the diagrams indicates that the maximum increase of resistance is at the point where the amplitude of heave and pitch is only about half, or somewhat less than half, of the maximum of the heave and pitch. That seems to me rather difficult to explain.

Mr. G. de Rooij : I am very interested in the electric welding of ships, and so far as I can see nothing is said as to whether the ship is riveted or welded. I would like to ask which parts of the ship are electrically welded and, if possible, the number of items electrically welded.

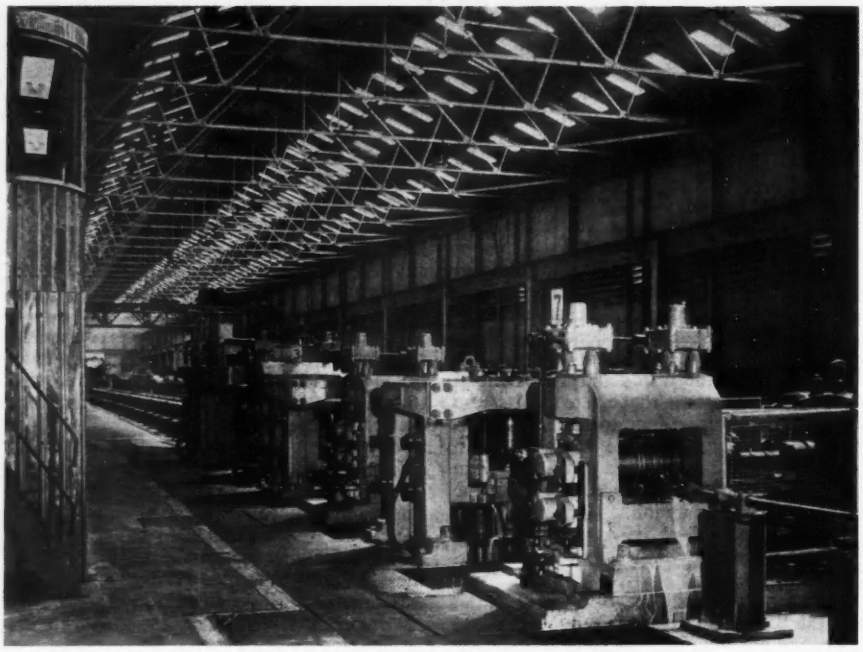
(*To be continued*)

Aluminium Wire and Cable Factory

With the object of centralising the production of aluminium and aluminium rod and wire for the engineering and other industries, three companies participated in the establishing of a works at Port Tennant, Swansea. The plant which occupies a site covering 10 acres has an annual capacity of 30,000 tons and produces wire, strip and electric cables and conductors.

AT Port Tennant, Swansea, are situated the works of the Aluminium Wire and Cable Company, Ltd., which is specifically engaged in the production of wire for the engineering industry, and the electrical industry, including overhead transmission lines and hot rolled rod. The company was formed in 1946 when British Aluminium Company, Ltd., Tube Investments, Ltd., and Hawker Siddeley Group, Ltd., decided to rationalise the production of aluminium wire and cable and so jointly transferred their interests in this particular field to the new company. A site, originally occupied by the English Crown Spelter Company, with good rail connection to the adjoining Swansea docks, was taken over and the existing buildings, erected in 1940, were cleared, modified and re-equipped. The plant covers an area of about 10 acres and the main building is 660ft long and divided into three bays each 50ft wide, while an extension some 275ft in length by 100ft wide serves for the storage of incoming aluminium ingots and cable drums. As planned, one bay is occupied by the semi-continuous hot rolling mill to produce wire from ingot, the centre bay houses the wire drawing machinery, and the third bay contains the stranding machines.

For engineering purposes and the aircraft industry, wire is manufactured in all grades of pure aluminium and in aluminium alloys to British Standard specification and including several alloys specially developed by the company. Round wire is produced in sizes ranging from $\frac{1}{8}$in diameter to 39 S.W.G., while other sections such as square, rectangular, hexagonal and triangular, are available, together with special sections as required, all of which can be supplied to any specified temper. Strip up to $\frac{3}{4}$in wide can be supplied and also rivet stock up to 1in diameter. Electrical purity wire of guaranteed conductivity is produced for the manufacture of insulated cables and windings while the company produces stranded conductors of steel-cored aluminium; all aluminium, "Silmalec" and steel-cored "Silmalec," together with a wide range of associated fittings. There is also produced $\frac{3}{8}$in, $\frac{7}{16}$in and $\frac{1}{2}$in diameter hot rolled rod in pure aluminium and most alloys.



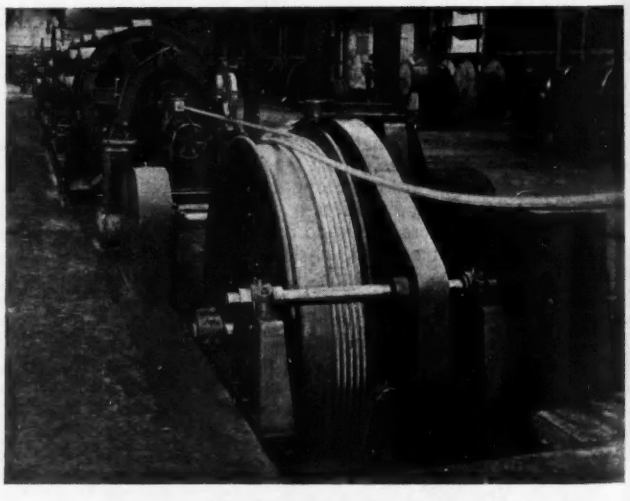
Wire Finishing Stands

Description of Plant

Ingots for wire manufacture and measuring 4in by 4in by 9ft are imported from Canada, though provision has been made to install the necessary melting furnaces and casting equipment for the production of the wirebars should this prove necessary at a later date. From the store the ingots are moved by a crane to the furnace bay in which three 620kW furnaces, manufactured by the Electric Resistance Furnace Company, Ltd., are installed. Each furnace has a capacity of 2 tons per hour, automatic temperature and overload control, and operates on the forced air circulation system. The furnaces are served by an automatic charger upon which the ingots are loaded and which delivers an ingot, at controlled intervals, on to a chain conveyor. This carries the ingot through the furnace in about three hours and finally discharges it at a temperature of about 400 deg. Cent., on to a power operated roller conveyor which delivers it to the roughing mill. This is a three-high, 21in, seven pass unit powered by a 500 h.p. electrical motor which runs at 740 r.p.m. and drives through a flywheel, reduction gears and a Wellman-Bibby coupling to a pinion stand to drive the three rolls. In the mill the ingot makes seven passes, during which it is reduced to an oval shape measuring about $2\frac{1}{4}$in by $1\frac{1}{4}$in along the major and minor axes. At each reversal of direction the impact energy of the moving bar is taken up smoothly by an automatic pneumatic dashpot buffer device using air at 20 lb per square inch.

After the final reduction in the roughing mill the bar is cropped to remove the split nose and proceeds to the five pass, 16in, two high repeater looping mill, both stands of which are driven by a 750 h.p. electrical motor in the same manner as the roughing mill. Both the roughing and repeater mill are shown in our general illustration of the mill on page 565. The five passes serve to reduce the oval section to one measuring about $1\frac{1}{4}$in by $\frac{7}{8}$in and this runs out on to a table from which it is pushed off on edge to another table leading to the seven stand finishing train, which we illustrate. Each stand is powered by a 150 h.p. motor driving through a reduction gear, except the last stand, which has direct drive. For changing flow paths a special motor is provided and this drives through a telescopic coupling to move the complete stand. A point of interest is that this finishing train, which has grooved rolls ranging from 15in

Eleven-Die Continuous Wire-Drawing Machine

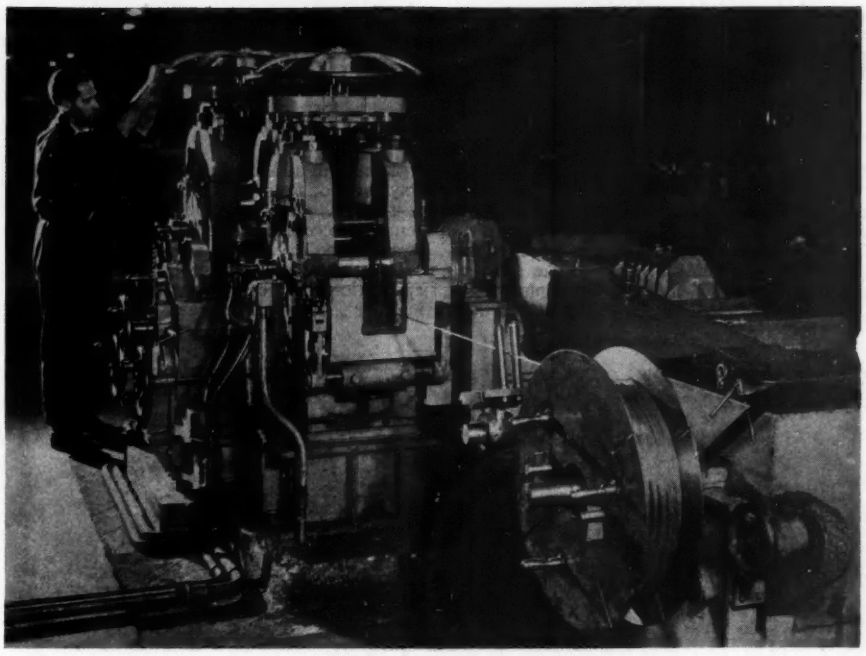


Fifty-Four Bobbin Stranding Machine

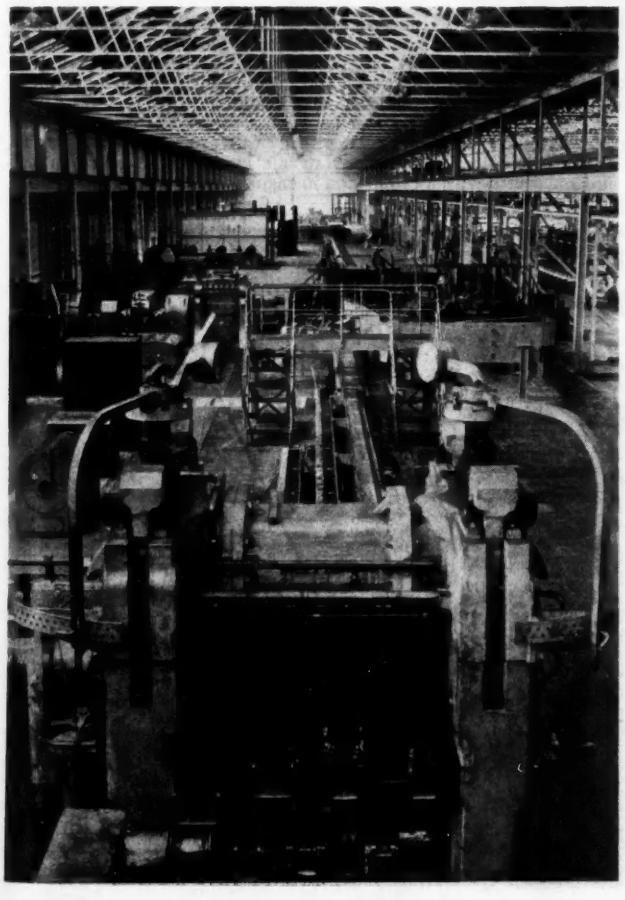
to 10¾in in diameter, is arranged with alternating horizontal and vertical rolls. For the latter the drive is below ground and the 150 h.p. motor drives the rolls through a pinion housing, reduction gear, bevel gears and a layshaft. This arrangement of rolls obviates the need for twisting the bar between stands and the associated risk of damage. From the finishing stand the bar is delivered at a speed of about 650ft per minute, depending upon its diameter, to the coilers and from these the coil is released to drop upon a slat conveyor. At the end of this conveyor the coil is strapped and picked by an overhead conveyor which delivers it to the shipping bay or to a stillage for transfer to the storage bins.

The hot mill was built by The Brightside Foundry and Engineering Company, Ltd., and powered by motors provided by the English Electric Company, Ltd., and has an output of 6 tons per hour or 30,000 tons per annum. Two " Broomwade " compressors each capable of delivering 300 cubic feet of free air per minute at 100 lb per square inch supply the air to the pneumatic mill controls. A soluble oil system is installed for the circulation of oil to the mill bearings and for cooling the roll grooves. It is a closed circuit system complete with adequate heating, cooling and filtering arrangements and three 400 g.p.m. Drysdale delivery pumps. For roll changing and service purposes the mill bay is equipped with a 15-ton Vaughan crane having Heenan and Froude slip coupling control.

The Marshall Richards Machine Company, Ltd., has supplied most of the machines in the wire drawing bay but some have been provided by W. H. A. Robertson and Co., Ltd., and Sir James Farmer Norton and Co., Ltd. As mentioned earlier, the equipment ranges from heavy duty breaking down units producing wire of over ¼in diameter to fine wire machines capable of producing wire of 39 S.W.G. For special breaking down work there are a few single and two die bull-blocks but the majority of the machines are of continuous multi-die pattern, designed for high speeds. They have three, five, seven, nine or eleven dies of tungsten carbide and are of both slip and non-slip design with operating speeds varying from 1000ft to 3000ft per minute. An eleven-die continuous wire drawing machine is illustrated in the photograph, which we reproduce on page 564. Diamond dies are used in the fine wire machines, that is those producing wire from 20 S.W.G. and 39 S.W.G. To maintain the dies to the close limits required by production there is a special maintenance shop equipped with machines supplied by Rudkin and Riley, Ltd., and with a B.I.S.R.A. profiloscope.



Tandem Mill for Flattened Wire



General View of Hot Rolling Mill

At some stage in manufacture certain alloys require heat treatment in order to develop maximum strength and for this purpose there are four batch pattern, 140kW electrical resistance, forced air circulation furnaces. They have automatic pyrometric control which keeps the temperature within ±2½ deg. Cent. and they were supplied by G. W. B. Electric Furnaces, Ltd., complete with charger and loading skips which measure 10ft 9in in length by 4ft 6in wide by 3ft 4in high.

For the manufacture of conductors there is a bay fitted with stranding machines of both tubular and planetary pattern, mainly supplied by the Trafalgar Engineering Company, Ltd. In these machines individual wires are laid around a central wire each layer consisting of a predetermined number of wires. A typical example being six wires laid around a central wire in one machine to form a seven strand conductor around which twelve strands are built followed by another eighteen strands and a final layer of twenty-four strands, thus making in turn a seven, nineteen, thirty-seven or sixty-one strand conductor. The tubular machines produce conductors up to seven strands while the largest of the planetary units is capable of producing a conductor having 169 wires. Our photograph on page 564 illustrates a fifty-four bobbin stranding machine. For handling the cable drums there is a 5-ton Clyde crane having a carriage constructed of aluminium alloy sections.

In a separate factory block there is a chemical plant for the treatment of consumable electrode wire used in " Argonaut " and " Aircomatic " welding sets. In many industries straight lengths of wire are required for machining purposes, welding rods and knitting needles, and to meet the demand there are a number of Thompson and Munroe straightening machines for wire up to ¼in diameter. For larger diameters up to ½in there is a Barron and Crowther heavy duty machine in which the rod passes through a rotating cylinder fitted with offset guides of wood or rubber. The equipment can provide straight lengths up to 16ft in all diameters.

The Port Tennant factory also produces narrow strip or tape or flattened wire, as it is more generally known within the industry, in small mills, one of which we illustrate above. A Robertson-Tormanco tandem flattening mill having 9in diameter rolls can produce strip up to ¾in wide at 200ft per minute, while a range of small mills having speeds up to 400ft per minute deal with the smaller sizes and have special equipment for layer winding into coils for such specialised applications as zip fasteners. Another strip machine of special interest was manufactured by D.E.C.O. Machinery, Ltd., and produces embossed strip for the jewellery industry. In the same block was a heavy duty wire drawing machine, supplied by W. H. A. Robertson and Co., Ltd., and powered by an English Electric 100 h.p. motor, for producing round bar up to 1in diameter for rivet stock.

Careful check is maintained on the materials used in well equipped laboratories ; there are tensile testing machines for both standard and fine wires, cable testing machines and the means for carrying out conductivity tests. A hardness testing machine is installed and there is provision for spectrographic analysis.

Heating of the factory is by a high pressure hot water system, fed from two La Mont water-tube boilers which are creosote pitch fired and produce a total of 18,000,000 B.Th.U. The water leaves the circulating pump at a pressure of 145 lb per square inch and a temperature of 330 deg. Fah. and returns at 295 deg. Fah.

Graduate School of Thermodynamics and Related Studies

LAST week we had the pleasure of visiting Birmingham University to hear about the Graduate School of Thermodynamics and Related Studies which has been operating there for the last two years. The purpose of the school is to provide facilities for the study at advanced level of modern developments in thermodynamics and allied subjects and of their applications in the general field of the heat engine.

The courses originated from the recognition that in this, as in other fields of applied science the major developments which have occurred within the last decade have brought with them advanced concepts and techniques which are perforce outside the scope of a normal undergraduate course. It was to teach and to disseminate this matter that the graduate school was established, since access to it must otherwise have remained difficult and laborious owing to its dispersal throughout a wide range of scientific and technical publications.

The present aim is to offer to a relatively small number of engineers who have achieved some measure of responsibility in the appropriate industrial sphere, the opportunity to study in an intensive and organised manner the latest theoretical and experimental techniques in their own and related fields. Even at a time when circumstances render difficult the release of graduates from industry, it is believed that the resultant infusion of fresh ideas and new viewpoints should prove an invaluable aid to progress and should more than compensate for the temporary inconvenience caused by such releases

Although nominally of one year's duration, the course is so arranged as to require only nine months' full-time attendance at the university, the final three months being occupied in the spare-time preparation, away from the university, of critical reports on the laboratory work carried out during the opening period. Although the above arrangement is designed to reduce to a minimum the period of the student's secondment from industry, it is considered that any shorter course of study could have little permanent value. Attendance at the university is required from early October until the commencement of the following July.

The normal entrance qualifications are an Honours Degree in Mechanical Engineering, together with a minimum of two, though preferably three or four, years of practical experience in industry. On completion of the twelve-month course, successful candidates qualify for the award of the Degree of Master of Science.

In special circumstances, we understand, applications may be considered from graduates in other sciences with suitable engineering experience, or from non-graduate engineers holding satisfactory alternative qualifications. In the latter case, it will usually be necessary for two years to be spent in completing the course, the preliminary year comprising lectures and laboratory work selected from the third and fourth-year undergraduate syllabus. The award to successful non-graduate engineers is the Diploma of Graduate Studies.

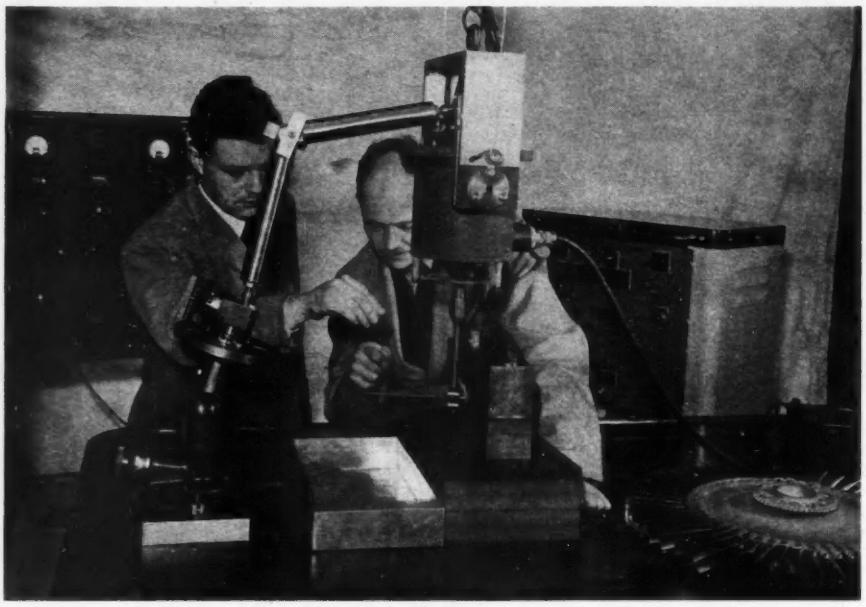


Fig. 1—Vibrations Table

The syllabus includes formal lectures, tutorial classes and laboratory work, the aim of the latter being to illustrate to the student the theories developed in his lecture courses, to afford him practice in scientfic methods of measurement and analysis and to familiarise him with modern techniques of instrumentation.

Although restricted to thermodynamics and associated subjects, with reference particularly to their application to heat engines, the course is in no way specialised in the narrow sense. The orientation is essentially towards the scientific approach and no attempt is made to deal, for example, with the details of practical design. The intention is rather to stimulate the analytic powers of the student, to familiarise him with modern thought and treatments, and to equip him with a comprehensive knowledge of advanced thermodynamics and its ramifications. This training, reinforced by industrial experience is intended to enable him to approach with confidence and vision the more complex problems of his particular facet of industry.

Syllabus

Of course, it is scarcely possible to demonstrate to a visitor how much of the work in such a course is composed of lecturing and the tutorial side. Nor is it easy to attempt any description of such work. Perhaps some conception of its scale is given by the fact that out of each week's work only about two days are spent upon experimental work. The following notes serve to indicate the intention and flavour of the lecture courses.

Thermodynamics and Gas Dynamics.—The two subjects are complementary and the dividing line is difficult to define. The general aim is to give the student a thorough knowledge of the basic principles and theoretical arguments associated with a wide variety of advanced topics, carefully selected as of potential value in the future development of the heat engine. Even where the state of knowledge in a relevant topic is such that a full analytical solution of a practical engine problem is either impracticable or uneconomic, a quantitative understanding of the idealised phenomenon can be of immense value in suggesting a suitable experimental approach and in providing a rational interpretation of observed data.

Dynamics of Machines.—The course is primarily concerned with torsional and flexural vibrations of all kinds, their excitation and elimination in engines and the dangers associated

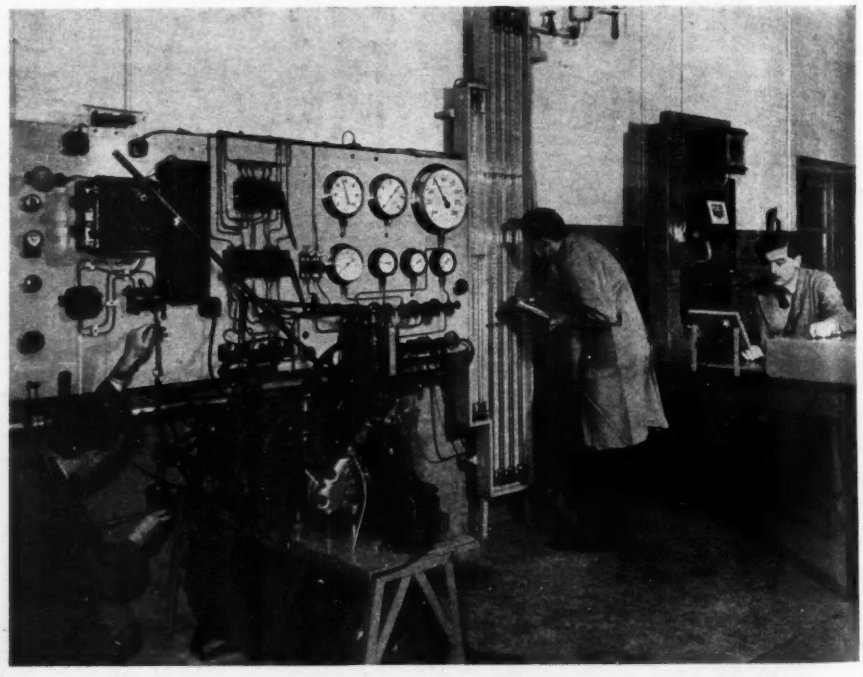


Fig. 2 - Induction Ramming of High-Speed Compressor

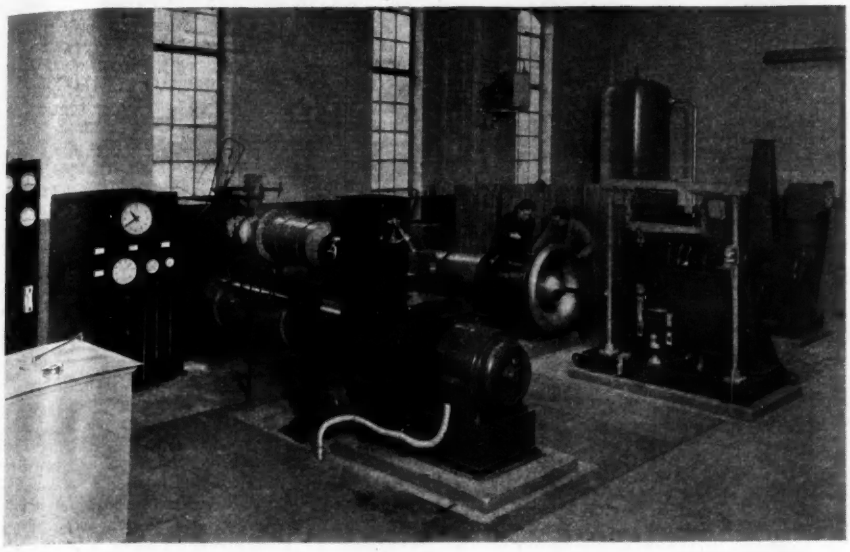


Fig. 3—Teaching Gas Turbine Installation

with resonance. Modern analytical treatments for predicting the modes and frequencies of such vibrations are dealt with in detail and, where possible, confirmed by laboratory experiments.

Elasticity of Materials.—The lectures cover a variety of analytical treatments for the calculation of stresses in awkwardly shaped engine parts. A typical example is the application of relaxation methods to a number of complex cases.

Instrumentation and Electronics.—This course, almost entirely descriptive and run in close conjunction with the laboratory classes, is designed to introduce to the student the very wide range of equipment, electronic and otherwise, available for measuring and recording engine phenomena. It is also intended to promote a critical approach in the use of such instruments, emphasising their respective potentialities and limitations and the precautions to be observed in their employment. The lectures on electronic equipment are not such as could produce electronic engineers. The aim is rather, by considering the underlying principles of a number of standard instruments, circuits and circuit elements, to remove that suspicion with which many mechanical engineers regard electrical devices.

Mathematics.—The object is to develop a confidence and facility in mathematical techniques applicable to engineering problems rather than to attain a high standard of proficiency in pure mathematics. The emphasis is everywhere on effectiveness rather than elegance of approach and numerical methods are extensively employed. Ample opportunities are given for the use of calculating machines. This subject is presented not by a mathematician, but by an engineer.

Oil Engine Practice.—Given by an eminent practising engineer engaged in the oil engine industry, this descriptive course gives an insight into the various applications of the oil engine, the factors influencing present and probable future trends of development and the potentialities of the oil engine in relation to other prime movers. Operational practice is also discussed.

Laboratory Equipment

Some of the laboratory equipment we were shown is illustrated by accompanying engravings, and though much else was seen we confine ourselves here only to the equipment illustrated.

The vibrations table illustrated in Fig. 1 forms one of the main items in the vibrations laboratory and is of general application in demonstrating and investigating forced vibrations and resonances in various engine parts. The apparatus comprises a 40W de Havilland vibration motor (type "1/E," Mk. II), complete with associated amplifiers (types "3/A1" and "3L/A1," Mk. II), and used in conjunction with the Muirhead-Wigan decade oscillator (type "D-105") for precise setting of excitation frequency.

The experiment which we saw being conducted concerned the excitation of various modes of vibration in a compressor blade, the plotting of the nodal patterns by the use of sand or lycopodium powder, and the measurement of amplitudes by means of an electronic pick-up, amplifier and oscilloscope.

The teaching gas turbine installation, illustrated in Fig. 3, was designed and installed specially for graduate school use and is intended for an examination of the basic phenomena in the separate components of a gas turbine, rather than a consideration of the characteristics of a complete power producing plant. The installation includes a three-stage, low-pressure-ratio, axial-flow compressor driven by a 130 h.p. d.c. motor arranged as a swinging field dynamometer. Power is supplied by an adjoining motor generator set using Ward-Leonard control. Blade angles may be adjusted between trials and traverse gear between the fixed and moving blade rows in the final stage permits an examination of the air flow through the blading. An alternative rotor and blade system, at present in the course of design, will allow conversion of the machine into a cold-air turbine for corresponding fundamental experiments on the air flow. Air for the turbine will be provided by a Keith-Blackman centrifugal blower driven by a 70 h.p. induction motor. The latter machine is already installed and can be seen in the engraving. Arranged in series, the axial and centrifugal blowers supply air for atmospheric pressure combustion experiments, using an aircraft combustion chamber equipped with suitable traverse gear. The provision of a small-scale, closed-circuit wind tunnel, to be operated by the blowers, is also intended and much of the ducting is now complete. The compressor-turbine was designed in the department and, apart from fabrication of the casing, wholly constructed in the workshops. The combustion chamber and its associated fuel system were very generously supplied by the appropriate departments of Joseph Lucas, Ltd., of Burnley and Birmingham, respectively, and both departments gave valuable advice concerning the installation and operation of their units.

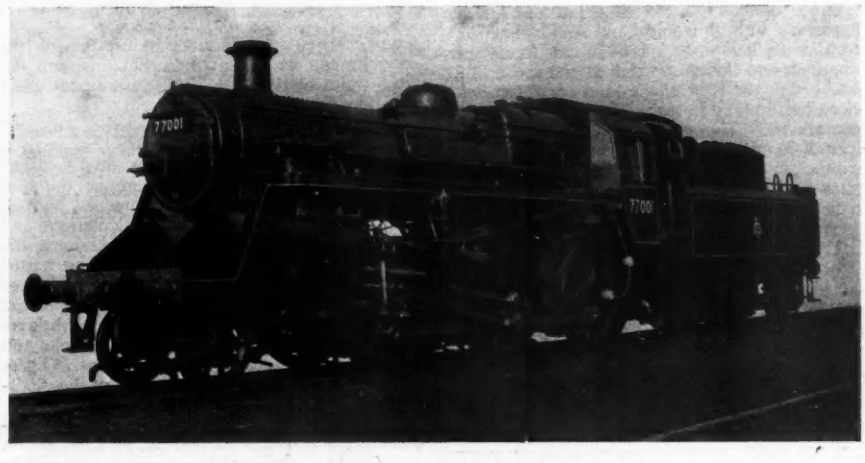
The apparatus illustrated in Fig. 2 for experiments upon induction ramming was, until very recently, used for a research investigation, but is now solely used for graduate school experiments. It consists of a small single-cylinder air compressor driven by a swinging field d.c. motor. Air flow is measured by an orifice type flowmeter and indicator diagrams from inlet port and cylinder are recorded using a rotary indicator, embodied in a specially constructed cylinder head and driven at crankshaft speed through an adjustable phasing gear. As originally presented by the makers (the Hymatic Engineering Company, Ltd., Redditch), the compressor was an air-cooled vee-twin machine driven at 1425 r.p.m. by an induction motor. Conversion to a single-cylinder, water-cooled machine was carried out in the departmental workshops, as was the construction of the modified cylinder head incorporating the indicator. Epicyclic phasing gear was also designed and made in the department. The trials now carried out by students comprise typical experiments from the original research programme. The aim is to demonstrate and explain the effects on compressor performance of piston-excited pressure waves in plain induction pipes of various lengths and diameters. For each selected pipe length the air flow and driving torque are observed and compared with those obtaining in the absence of a pipe. Indicator diagrams recorded under various conditions are also compared with those constructed theoretically.

British Railways' Class "3" Standard Tender Engines

The first of the new standard class "3," 2–6–0 tender engines for British Railways has now been completed at the Swindon works of the Western Region.

Of the twenty locomotives to be built, ten are to be allocated to the North Eastern Region and ten to the Scottish Region. The engines were designed under the direction of Mr. R. A. Riddles, who at the time was the Railway Executive Member for Mechanical and Electrical Engineering. The parent office for design was Swindon, but certain details were undertaken at Brighton, Derby and Doncaster.

The tractive effort of 21,490 lb of the new tender engines is the same as that of the class "3," 2–6–2 tank engines previously built at Swindon. Like the tank locomotives, these tender engines have almost universal availability over main and secondary lines throughout



Standard Class "3" Tender Locomotive

Britain, and they have been designed to replace various tender engines of similar power classification now becoming obsolete.

One of the new locomotives is illustrated on page 567 and the leading dimensions are as follows :—

Cylinders (two), diameter and stroke	17½in by 26in
Wheels, coupled, diameter	5ft 3in
Wheels, pony truck, diameter	3ft
Wheelbase, coupled	15ft 4in
Wheelbase, total engine	24ft 1in
Wheelbase, engine and tender	46ft 11½in
Heating surface :	
Tubes	932·9 square feet
Firebox	118·4 square feet
Total evaporative	1051·3 square feet
Superheater	190 square feet
Grate area	20·35 square feet
Boiler pressure	200 lb per square inch
Tractive effort	21,490 lb
Adhesion factor	5·08
Weight of engine in working order	57 tons 9 cwt
Weight of engine and tender in working order	99 tons 12 cwt

The boiler, which is the same as that used on the tank version, follows closely the design of the former G.W.R. Standard 2, used on the " 5100," " 8100 " and " 5600 " classes. A rocking grate and self-emptying ashpan are fitted, the details, wherever possible, being the same as those on other standard classes. The boiler mountings, regulator, clack valves, manifold and smokebox details are the same as those on the tank engines.

The engine frame, as on previous British Railways standard locomotives, is adequately stayed both horizontally and vertically, whilst the boiler securing arrangement, the spring gear arrangement and the method of staying axlebox guides are similar to those obtaining on other classes.

The wheel arrangement is the same as on the tank version, but without the trailing pony truck. Other items of similar design include the cylinders, axleboxes, axlebox guides, lubrication, cylinder cock and sanding arrangements.

The tender is the standard B.R. " 2A " design and takes 6 tons of coal and 3500 gallons of water, and although smaller, follows the pattern used for classes " 6 " and " 7," 4–6–2 and class " 5," 4–6–0 locomotives.

Her Majesty's Yacht " Britannia "*

By SIR VICTOR SHEPHEARD, K.C.B., R.C.N.C.†

No. I

In this paper details of the planning, design and construction of Her Majesty's Yacht " Britannia " are given. The co-ordination of the requirements for both yacht and hospital ship is described, as are the exhaustive tests to determine the hull form, the design of propeller, the shape of the funnel, seaworthiness and the minimum dimensions. Particulars are recorded of the equipment and the paper includes plans of the general arrangement of the ship and of the machinery.

In 1938, the Admiralty considered the possibility of building a ship which would not only replace the Royal Yacht " Victoria and Albert," then nearly forty years old, but which could be economically converted to a hospital ship in the event of war. With the advent of war the matter was dropped ; however, the project was revived in 1951, but reduced in size.

It was decided that the ship should be suitable for service in both tropical and Arctic waters. A continuous sea-going speed of 21 knots was required, and this meant that a trial speed of 22 knots with the ship in the load condition, with clean bottom and in temperate waters, had to be guaranteed. The endurance required was at least 2000 miles at 20 knots at load displacement with clean bottom and in temperate waters, allowance being made for the maximum load required for auxiliary machinery and for domestic services.

The necessity for economy in the cost of construction was kept in mind during the design and construction of the ship, but it was necessary to ensure that the size was not so reduced as to impair her seaworthiness when undertaking long ocean passages. Moreover, the ship had to be large enough to permit economical employment as a hospital ship in wartime, and it was decided that the smallest ship to meet these requirements was one of about 4000 tons displacement.

* Institution of Naval Architects' Spring Meeting. Abstract.
† Director of Naval Construction.

A photograph of " Britannia " on trials is reproduced in Fig. 1, and indicates that " Britannia " has been given a modern appearance with clipper bow and modified cruiser stern.

The principal dimensions and other leading particulars of " Britannia," as built by John Brown and Co. (Clydebank), Ltd., are :

Length overall	412ft. 3in
Length on waterline	380ft
Length between perpendiculars	360ft
Maximum breadth moulded	55ft
Breadth at upper deck moulded	54ft 6in
Depth moulded to upper deck, 45ft abaft amidships	32ft 6in
Depth moulded to upper deck at fore perpendicular	40ft 4in
Depth moulded to upper deck at after perpendicular	33ft 10in
Light displacement	3990 tons
Load displacement	4715 tons
Mean draught at load displacement	15ft 7½in
Gross tonnage	5769 tons
Shaft horsepower	12,000
Speed on trials at 12,000 s.h.p. (at 4320 tons displacement)	22·75 knots
Corresponding r.p.m.	286
Continuous sea-going speed	21 knots

Masts	Height above U.S.K. to top of aerials	Rake
Fore mast	133ft 0in	1¼in per foot
Main mast	139ft 3in	1¼in per foot
Mizzen mast	118ft 10in	1¼in per foot
Rise of floor	12in	

Sheer forward on upper deck at *FP*	7ft 10in	On 380ft length *LWL*
Sheer aft on upper deck 20ft 0in abaft *AP*	1ft 9½in	

Hull coefficients (moulded) 15ft 3in full draught :	
Block	0·518
Prismatic	0·562
Midship area	0·922
Waterplane	0·687
Bulbous bow coefficients (Taylor) :	
f	0·036
t	0·637

In the load condition the ship carries 330 tons of oil fuel, which is more than sufficient to obtain the design endurance of 2000 miles at 20 knots, and 120 tons of fresh water which is considered sufficient for two days' supply without evaporators working.

Extra tank capacity is available for use on long ocean passages, and by its use the oil fuel capacity can be increased to 490 tons and the fresh water to 195 tons. These additional tanks will normally remain empty.

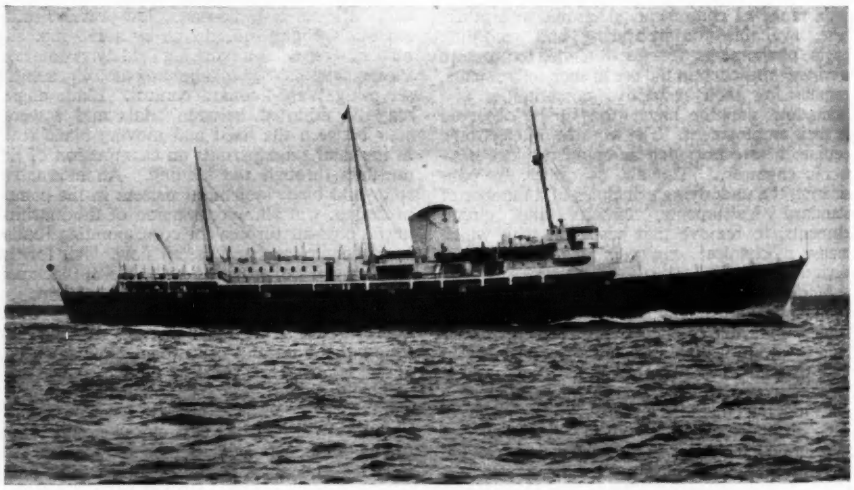


Fig. 1—Her Majesty's Yacht " Britannia " on Trials, November, 1953

Ship Model Experiments

Arrangements were made for investigations and model experiments to determine the best form of hull to meet the requirements, both in calm waters and rough seas. Calculations and experiments were also made to determine the most suitable design of propeller having regard to propulsive efficiency and the avoidance of cavitation, erosion and vibration. Wind tunnel tests were carried out to ensure that the bridges would be as free from draughts as possible, and to obtain a satisfactory design of funnel. These wind tunnel tests were conducted by the Aerodynamics Division of the N.P.L., Teddington.

The first experiments to determine the resistance of the hull were carried out by John Brown and Co. Ltd., and a model was run in the tank at Clydebank at a displacement corresponding to 4470 tons, level trim, over a speed range from 14 to 22 knots. Afterwards A. E. W. Haslar ran a model to slightly different displacement and draught and compared the results with those of other good hulls of about the same proportions and speed, and confirmed that the hull lines were of a very good standard throughout the speed range. John Brown and Co. Ltd., then proposed a semi-bulbous bow as showing an improvement in performance above 18 knots, although performance was slightly prejudiced below that speed.

One of the essential requirements was that the ship should be as free from vibration as possible. Before deciding on the propeller design, therefore, calculations were made at A. E. W. Haslar of the natural frequency of vertical flexural vibration of the hull for guidance in determining the number of blades to avoid propeller excitation. The method of basic functions was followed and allowance was made for the influence of entrained water, shear deflection and rotary inertia. Calculations covered the first nine nodes and the predicted frequencies ranged from 116 cycles per minute for two-node vibration to 708 cycles per minute for nine nodes.

The method followed is intricate and fairly lengthy, but it is regarded as such a promising advance on previous approaches as to justify the work involved, and a similar approach for a ship of comparable size indicated that the method was trustworthy to cover the range of interest for " Britannia." It was deduced that three-bladed propellers might stimulate resonance due to shaft excitation superposed on blade excitation over a speed range of 16½ to 19 knots. Resonance due to shaft excitation with four-bladed propellers might be excited from 16 to 18 knots and with blade excitation from 14 to 15 knots. Experience on comparable ships suggested that transverse hull vibration might also be excited over the speed range quoted above for three-bladed propellers, but only at lower speeds for four-bladed propellers. Resonant vibration might also be excited at lower speeds than mentioned, but experience confirmed that this would be slight and unobjectionable. Thus vibration might be expected at lower speeds with four-bladed propellers than with three-bladed propellers. On the whole the risk of objectionable vibration was regarded as slight with four-bladed propellers, whereas objectionable vibration might be induced with three-bladed propellers due to a combination of nodes and frequencies.

It was therefore decided to fit four-bladed propellers rather than three-bladed, and accept an estimated loss of speed of one-eighth knot. A. E. W. Haslar worked out proposed particulars for a four-bladed propeller and John Brown and Co. Ltd., prepared the detailed propeller design with the characteristics given in the table. With this diameter propeller a good tip clearance of 2ft 9in from the hull was obtained.

Torque and normal force on the rudder were

determined from measurements on a propelled model hull when on a straight course with rudder adjusted in turn to various angles. Maximum rudder torque was estimated to be 125 tons-feet at 14 knots astern and 30½ deg. angle. The torque was reduced to 116 tons-feet at 35 deg. angle, but was larger at greater angles outside the operating range. When proceeding at 22 knots ahead the torque was 69 tons-feet and at 15 knots was 33 tons-feet both at full rudder angle of 35 deg. Maximum normal rudder force was estimated to be 63·5 tons at 22 knots ahead, and 25·5 tons at 14 knots astern.

Propeller Characteristics

Diameter	10·25ft
Pitch	9ft
Area	55·7 sq ft
Number of blades	4
Blade area ratio	0·675
Blade thickness ratio	0·056
Revolutions per minute	275
Speed	22 knots
Wake	12·35 per cent
Advance coefficient	0·704
Immersion	8ft 8·5in

The centre of pressure was abaft the rudder axis at all forward speeds and for all rudder angles tested. The results indicated a small discontinuity in the progressive increase of torque and force with angle in ahead motion at about 30 deg. to 35 deg. and a definite stalling at 30½ deg. in astern motion. Geometrically the rudder enters the propeller race at about 30½ deg. and the discontinuity may be due to the influence of the propeller race associated as stern motion with the usual stalling phenomena which depend, among other factors, on aspect ratio.

The normal force coefficient at 22 knots ahead and 35 deg. angle was 0·026, which compares with a general average value of 0·03 for ships generally, subject to a margin of 10 per cent or so up and down. (Normal force coefficient is $P/AV^2\theta$, where P=force in pounds, A=rudder area in square feet, V=speed of ship in feet per second, θ is the rudder angle in degrees.)

Comprehensive experiments were carried out at A. E. W. Haslar to investigate the sea-keeping qualities of the ship. A dynamic model to a scale of one-thirty-second full size was tested head-on to uniform waves when towed at speeds corresponding to 10, 15 and 20 knots and in following waves at speeds corresponding to 10 and 20 knots. Tests were also made with the model hove-to head on to the waves. The wave lengths ranged from 200ft to 700ft at full scale with heights one-twentieth and one-fortieth the length.

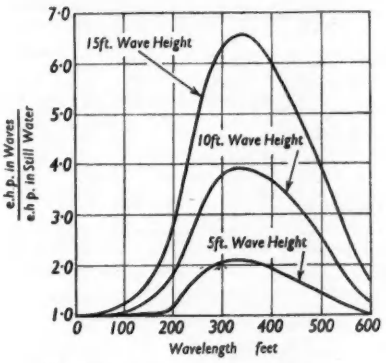
The motion in ahead seas was heavy in long waves, but was reduced in short waves. Generally, peak oscillations occurred in waves about 30 per cent or so longer than the ship and were more severe at high speed. As an indication of the severity of the extreme motions it may be mentioned that the maximum amplitude of pitch was about 20 deg. (out to out) and of heave 32ft (out to out) when the ship was proceeding at 20 knots in waves about 500ft long, and it is of interest that the motion is still severe when the ship is hove to.

A considerable increase in hull resistance occurs in waves, as is evident from Fig. 2, which shows the variation in e.h.p. with wave length for various wave heights at a speed of 10 knots. The maximum speed that can be sustained at sea with full machinery power was deduced from the results to be about 20 knots in waves 4ft high, reducing to about 10 knots in waves 20ft high. The experiments verified that the design had good sea-keeping qualities, except that in waves 400ft long and 20ft high green seas were taken over the bow at all speeds. Heavy spray was thrown over the bridge. The height of the bulwark at the bow was increased from 4ft to 6ft, a modification which caused conditions to improve considerably, and with the ship trimmed 2ft. by the stern no water at all was taken over the bow in any condition of speed of model and size of wave investigated.

Construction

All the structural plans for "Britannia" were submitted to Lloyd's Register of Shipping and the vessel has been assigned the classification ✠100A1 with freeboard corresponding to a summer moulded draught of 16ft 6in.

The upper, main and lower decks are worked continuously over the entire length of the vessel, except in way of boiler room uptakes, and the platform deck is watertight throughout. Main watertight transverse bulkheads are carried to the upper deck, although from a sub-division point of view it would have been sufficient had they been terminated at the main deck. There are no openings in these bulkheads below the lower deck. The ship is transversely framed, the frame spacing being 2ft. The shell plating above the light waterline is worked flush. Below the waterline the plating is lapped but the plate edges forward have been faired with composition. Butts of shell plating below the waterline and the shell plating in way of reserve feed tanks and



Ahead seas.
Variation of e.h.p. with wavelength and height.
Ship speed, 10 knots.

Fig. 2—Variation of E.H.P. with Wavelength

fresh water tanks are welded. The internal boundaries of the oil fuel tanks are also welded.

Aluminium has been used for the superstructure above the bridge deck and for the funnel. The minimum 'tween deck height is 8ft with 10ft throughout the State apartments. The after end of the sun deck has been stiffened so that it can be used, if required, as a helicopter landing deck.

The bridge front is terraced to provide deck space at shelter deck level for an admiral's bridge and at bridge deck level for a Royal bridge, but the problem of wind protection on these bridges proved much more difficult to solve than with the conventional cliff front. Wind tunnel experiments at the N.P.L., Teddington, on a large-scale model of the bridges showed that the bulwarks and screens alone were insufficient to prevent the wind striking the structure at the back of the bridge and descending in strong eddies on to the deck of the Royal bridge. Experiments were conducted to find the optimum position for a screen, and it was finally fitted 3ft 6in from the superstructure (though this position was not found to be critical) and with a height of 3ft 10in. Also extensions at each side, of full height between decks, were fitted to the front of the Royal charthouse to protect the entrances to the chart house from the high wind velocities in the wind alley.

Accommodation

The Royal apartments are on the shelter deck between the main and mizzen masts with a verandah at the after end leading on to a sun deck. The main staircase from the Royal apartments on the shelter deck leads to a vestibule on the upper deck about which are grouped the State apartments. At either side of the vestibule are Her Majesty's and His Royal Highness's sitting rooms. The dining room, drawing room and ante-room extend the full width of the superstructure without obstruction from pillars. Sliding screens are fitted at the entrance to the ante-room and between the ante-room and the drawing room. They can be folded back, when required, to provide a large reception space from the after end of the drawing room to the foot of the main staircase.

The main staircase continues down from the upper deck to the main deck, in the vicinity of the main entrance ports. The household and guest cabins, sitting rooms and cloak rooms are on this deck. The Royal staff is accommodated on the lower deck. A passenger lift is fitted near the main staircase and operates between the main and shelter decks. The crew of twenty-one officers and 250 men is accommodated forward in a manner generally in accordance with Service practice, except that the C.P.O.s occupy four-berth cabins.

In the interests of economy, use has been made as far as possible of furniture from the "Victoria and Albert" and of new pieces supplied for use in S.S. "Gothic" for the Commonwealth tour.

In the initial stages of the design the Medical Director-General of the Navy was consulted about the requirements for the vessel in her role as a hospital ship. In consequence, relatively little alteration to existing structure and equipment will be required in the event of war.

As a hospital ship the wards, which will accommodate 200 patients, will be located aft. Most of the patients will be medical and surgical cases, requiring normal hospital conditions, but provision has also been necessary for zymotic cases and those suffering from tuberculosis. The operating theatre, with its annexes and its adjacent steriliser and anæsthetic rooms, will be on the lower deck, where there will also be the other specialist facilities.

Four main cold and cool rooms are provided for the storage of provisions. The two cold rooms for meat and fish are large enough to provide supplies for forty-five days for the ship's company. The dairy and the fruit and vegetable rooms are of sufficient capacity for thirty days. The cooling machinery for the cold and cool rooms and for icemaking consists of two electrically driven, water-cooled cooling plants, using Freon 12/Arcton 6 as the refrigerant, each machine being fitted with independent control valves.

An air conditioning system serves the after accommodation spaces and has been designed to maintain an inside condition of 85 deg. Fah. dry bulb and 71 deg. Fah. wet bulb when the outside atmospheric condition is 88 deg. Fah. dry bulb and 80 deg. Fah. wet bulb. Under cold weather conditions the installation will maintain an inside temperature of 70 deg. Fah. when the outside temperature is 30 deg. Fah.

The refrigerating machinery for air conditioning comprises two steam jet vacuum plants, each capable of extracting 1,000,000 B.Th.U. per hour under tropical conditions. The cooling medium is chilled water circulated to thirteen air conditioning units each of which serves a particular section of the ship. The heating medium is warm water circulated to the units through heating calorifiers.

To keep noise levels to a minimum fans and units have been grouped in acoustically lined chambers and, where necessary, trunking has also been acoustically lined. No recirculation of conditioned air is used in the system, fresh filtered air being supplied whether cooling, heating or mechanical ventilation is in operation.

The forward accommodation spaces for the ship's company are ventilated by fan supply and exhaust; they are heated by Admiralty pattern gilled tube type heaters in the fan supply, capable of maintaining an inside temperature of 70 deg. Fah. when the outside temperature is 30 deg. Fah. These systems are manually controlled, the temperature being regulated by means of bypass valves in the heater units. Galleys, bathrooms, workshops, &c., are ventilated with air at atmospheric temperature by fan supply and exhaust.

(To be concluded)

Codes of Practice

The Institution of Civil Engineers, Great George Street, Westminster, has now published *Civil Engineering Code of Practice No. 4: Foundations.* The code is published on behalf of the Civil Engineering Codes of Practice Joint Committee, on which the Institutions of Civil, Municipal, Water and Structural Engineers are represented, and its cost is 15s. The general principles of design in relation to bearing pressures and earth pressures are first expounded, followed by more detailed considerations of the design and installation of the main types of foundations. Site operations and construction methods are subsequently described in five sections under the headings of demolition, shoring, underpinning and excavation; de-watering and treatment of sub-strata; tide-work; underwater concreting, and diving. The durability of various materials employed in the foundations of structures is discussed in the last part, and some steps which may be taken to prolong the life of these materials are noted.

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WAGES SETTLEMENT

Last week a conference of executives of the unions affiliated to the Confederation of Shipbuilding and Engineering Unions signified, by a large majority, acceptance of the wage increases offered by the Engineering and Allied Employers National Federation and the Shipbuilding Employers Federation. Those increases, as reported in our last issue, amount to 8s. 6d. a week for skilled men, 7s. 6d. for semi-skilled, and 6s. 6d. for unskilled men in the engineering and shipbuilding industries. They represent an addition of approximately 6 per cent to the existing weekly rates, and are therefore a little above the suggestion of 5 per cent proffered by the Courts of Inquiry which recently examined the dispute. Agreement has thus at length been reached on a matter which has been under discussion for nearly a year. As long ago as last April, the Confederation of Shipbuilding and Engineering Unions decided that it would put forward a claim for a 15 per cent increase in the consolidated time rates of adult male workers. That would have meant an addition of something like £1 a week of forty-four hours to the wages of skilled men and about 18s. for unskilled men. The claim was considered in detail by the two employers' federations, there were several conferences with the union representatives, and, last November, there were full explanations as to why a claim of such magnitude could not be granted at a time when order books tended to diminish and when it was imperative, to counter growing competition in world markets, that manufacturing costs should not be increased. The unions' response to the rejection of the 15 per cent claim was a twenty-four-hour "token" stoppage of work early in December and a subsequent threat to ban overtime and restrict piecework.

Fortunately, through the intervention of the Minister of Labour and the establishment of the Courts of Inquiry, the threatened ban on overtime and piecework did not materialise. The main findings of the two Courts of Inquiry have already been commented on in these columns. Those findings and the Courts' suggestion to both sides that negotiations should be resumed have led to the settlement which has now been announced. In their reports, however, the Courts of Inquiry have put on record several matters, which were not only relevant to the outstanding dispute, but which are also relevant to the general wages structure of the engineering and shipbuilding industries. One of the reports—that concerned with the engineering industry—points out, for example, that the complexity and variety of engineering products necessitate very diverse skills among the industry's workpeople. The history of the wage structure amounts for the most part to repeated attempts to bring a variety of methods of wage computation into a national code of basic rates for skilled and unskilled workers, whether they are on time or piece rates. It may be recalled that a Court of Inquiry which examined a wage dispute in 1948 urged that there should be some simplification of the engineering wages structure. In the two succeeding years some preliminary steps to that end were taken, but the main task of formulating a new engineering wages structure remains unfinished. It has had to be set aside because of claims for percentage increases on existing rates, which have been put forward and have had to be negotiated nearly every year since the idea of a revised wages structure was first mooted. That, no doubt, is one of the primary reasons which led the recent Court of Inquiry to recommend that "the parties should give consideration to the setting up of some joint body which could keep wages and related matters under periodic review." There certainly is, we feel, a place for a joint body of the kind; it could usefully turn its attention to the creation of a less complicated engineering wages structure. For although, happily, a settlement of the latest dispute has now been made, it cannot be said with assurance that there is complete unanimity, especially in the matter of "differentials" between skilled craftsmen and unskilled workers.

Nevertheless, the immediate concern of the engineering and shipbuilding industries is to meet the cost of the wage increases which have been agreed. It has been computed that they may add between £60,000,000 and £70,000,000 to the annual wages bill. During the negotiations last year the unions argued that profits were such that the industries could well provide wage increases without adding to the price of their products. The reports presented by the Courts of Inquiry contain some very pertinent observations on this matter, particularly in so far as companies' reserves are concerned. The reports emphasise that normally an increase in wages must be looked upon as a permanent charge and, in general, therefore, it is to *future earning power* that regard must be paid when considering whether any increase in wages can be borne out of profits. It is true that the engineering and shipbuilding industries may expect some relief from their heavy burden of taxation by the investment allowances provided for in this year's Budget. But it is equally true that their future earnings will shrink unless the highest quality products are forthcoming at competitive prices. Engineering goods now provide nearly half of this country's exports, which means that the engineering and shipbuilding industries—and the nation—are more dependent than ever before on their exports for their prosperity. "Higher productivity" is certainly becoming a much overworked phrase in the everyday language of this country, yet with intensified competition from abroad it still represents the key to continuing prosperity in British engineering and shipbuilding.

EDUCATION WITHIN INDUSTRY

Now that the sellers' market has broken and competition is growing in world markets it is becoming increasingly apparent that the level of exports from this country can only be maintained if British industry is prepared to offer buyers machinery not only of high quality but also of advanced design. But if British industry is thus to concentrate upon goods of advanced design and to use improved productive methods then the application of technologies in British industry will need to be in advance of that of the rest of the world. It follows, of course, that the number of technologists in industry needs to be expanded. But that in itself is not enough. Those technologists will continuously need to be kept informed about technical advances and instructed how best to make use of them. To some extent, no doubt, the job of spreading information of that character falls upon the technical press, engineering institutions, research bodies, industrial associations and the like. No doubt that is the reason why research bodies and industrial associations sponsor summer schools and why institutions, especially since the war, have organised symposiums of lectures and papers. But they cannot wholly meet the need. For it is not only information that is required. Instruction also is demanded and preferably personal instruction.

The task is in reality an educational one, best organised and carried out by ordinary educational establishments as an addition

to their primary work of training students in courses leading to degrees, diplomas and certificates. An example of what we mean is provided by that Graduate School of Thermodynamics and Related Studies that has been operating at Birmingham University for the last two and a half years and which is described on another page of this issue. As befits a university course this one is fundamental in character. But it is specifically intended to meet the needs of younger men who have already had several years' experience in industry, who have already begun to specialise in certain fields, who are likely to have found how difficult it is to collate from many sources (even if they can be found) the particular fundamental knowledge that they require and who lack, in industry, the possibility of carrying out the practical experiments that so much illuminate the application of theoretical knowledge. That course requires nine months' full time attendance at the university and three months subsequent part time work upon return to industry. Similar courses, in a wide variety of subjects, are now being operated by many universities, colleges and other bodies. Some, similarly, call for full-time attendance over considerable periods, some for absences from work of only a few days ; some consist only of a course of lectures ; or possibly only of a single lecture in the afternoon or evening. But all have one point in common. They depend for their success on the co-operation of industrial firms and more particularly of that of executives in senior positions who are able to decide whether juniors shall be temporarily released to undertake the courses or whether they shall not. Nor is that all. If the potential value of such courses is to be realised use must be made of the men who have attended them. For we can imagine nothing more frustrating to a younger man who labours hard and enthusiastically in such a course than to find upon his return to his firm or upon his taking up other employment that no use is to be made of his newly acquired knowledge and that he has acquired no merit in the eyes of the firm. The co-operation of industry is all the more required because this tendency for educational bodies to arrange courses of a post-graduate and industrial character is predominantly a post-war phenomenon. The effect upon industry cannot be immediate. A senior executive, hesitant about releasing a junior to attend a course cannot be convinced—yet—by an appeal to the virtues other firms have found in releasing men for the course. But that time will, we believe, surely come as the leavening of those within industry who have had experience of such courses grows stronger.

It was undoubtedly an appreciation of the need of men within industry for the further study of various subjects that led to the setting up after the war of Regional Advisory Councils for Higher Technological Education mainly to organise and co-ordinate in their regions courses and lectures in advanced technology likely to appeal to technologists within industry. Recently we had a discussion with the Council for London and the Home Counties. It emerged that difficulty is sometimes experienced in selecting subjects suitable for courses ; and that some of the courses have proved to be ill-attended. However, it is significant of that need for industrial co-operation that we have already stressed that a bad attendance is very seldom experienced if the subject for a course of lectures was originally suggested by an industrial firm. The Council therefore particularly welcomes such suggestions. Indeed, it feels that, whether because firms are unaware of what can be done by the Council to help them, because firms are diffident in making suggestions when only one or two of their own men could attend a course (forgetting that other firms' men might also welcome it) ; or because they can only formulate rather vaguely what kind of course they have in mind, there are too few suggestions. Maybe there are dangers in such an attitude. Educationalists can often see more clearly in educational matters than can industrialists. To depend too heavily upon suggestions from industry may be to weight courses too heavily towards those concerned with ephemeral contemporary practice rather than towards those of fundamental content whose value will be abiding. But the working out of satisfactory methods for the further education of men already in industry must be a co-operative job between educational establishments and industrial firms. It is a great and valuable experiment and in our view one essential to undertake if this nation is to maintain a reputation for advanced technological design.

Literature

Welding Engineering. By BONIFACE E. ROSSI. London : McGraw-Hill Publishing Company, Ltd., 95, Farringdon Street, E.C.4. Price 64s.

THIS book is a very welcome addition to the literature of a branch of technology which is notorious for its lack of good textbooks. This new work draws all its information and data exclusively from the most authoritative sources and consequently it bears the mark of authenticity in every chapter. The scope of the book is comprehensive and covers ground of interest to the welding engineer, designer and practical welder alike. It is written in a technically accurate and yet understandable way. The subject matter is divided into three main sections, dealing respectively with processes and equipment, metallurgy and weldability, and design and fabrication. In addition, there is a chapter on inspection and testing, some appendices of engineering data, and a carefully selected bibliography.

The first section commences with a survey of the various welding and brazing processes and their underlying principles, and then devotes a chapter to each principal process in turn. The metals and applications for which each process is particularly suitable are specifically stated. The work is up to date, with adequate details of the various inert gas processes and useful outlines of stud welding, cold welding, multiple-arc welding and other more recent developments. A noticeable omission is welding with continuous covered electrodes. The descriptive matter throughout is both theoretical and practical. All welding materials, plant and accessories are adequately described and there is a welcome chapter on safe practices and health precautions.

The section on metals and their weldability is particularly well written. It is informative and technically sound and lacks the superficial character of this section of most books on welding. After describing the principles of metallurgy, and the metallurgy of welding, the particular features of the welding of a wide range of metals and alloys are systematically dealt with in turn. Welding of clad steels and dissimilar metals is included.

The third section is of particular use to the designer. The field of application of welded design is broadly surveyed and special attention then given to joint design and stress calculations, layer sequence, deposition rates and costing, and distortion and residual stresses. The text of all sections of the book is amply backed up with tables of specifications, alloy compositions, procedural details and other useful data.

The main criticism of the book from the point of view of use in this country is that all the material is drawn from American sources. This introduces the mild disadvantage that all the equipment and materials which are described and specified are not normally available in this country, and that specifications of alloys, electrodes and so on, are American. It also accounts, for example, for the omission of any description of continuous covered electrode welding which is widely used in this country, but not in America. Similarly, the reader interested in " low hydrogen " or " basic " electrodes will not find this subject in the index under these headings, but will have to look under " Lime " or " Lime-Titanium " coverings. Other variations in nomenclature will similarly have to be taken into account.

In general, this book is a valuable addition to the bookshelf of any person concerned with welding and contains a mass of well-authenticated data within its covers.

Watch and Clock Making and Repairing. By W. J. GAZELEY. London : Heywood and Co., Ltd., Drury House, Russell Street, W.C.2. Price 42s.

MANY books have been written on the making and repairing of clocks and watches, but this recent addition to horological literature is a particularly useful one, for, in addition to being remarkably comprehensive, it is both clearly written and well illustrated. This is perhaps to be expected, for its author is Lecturer on Horology at the Northampton Polytechnic, Clerkenwell, London, and so has had much experience in the work of imparting technical knowledge.

The field covered in the sixteen chapters and the appendix is a large one, but this has not led to the volume becoming a mere catalogue of types of timekeepers and of the processes used in constructing and maintaining them. On the contrary, the information given throughout the work is both detailed and explicit. This, in itself, is no small achievement, for almost every kind of timekeeper, from the small wristlet watch to the large turret clock, is dealt with at some point in the book.

The chapter on tools is one of the best parts of the book, for in addition to describing and illustrating almost every kind of tool likely to be met with in horological work, the author endeavours to instruct the reader in the correct way to use them.

When dealing with the materials used in horology, and with the various kinds of watches and clocks in general use, ranging from the relatively simple to the distinctly complex, the author still retains this quality of clear expression. His descriptions of the actions of such things as different chronograph mechanisms, tourbillon watches and the complicated details of chiming and striking clock movements, are all very capably written. So, too, are the sections

dealing with watch and clock escapements, all the forms in general use being very thoroughly dealt with, and much useful information given on the construction and setting-out of the lever escapement, now so universally used.

As a knowledge of turning is so essential to the horologist, Mr. Gazeley devotes his second longest chapter to lathes, and their equipment, and to the methods of using them. All of it is very good in its way, but the author seems to have been so intent on watches and the making of such parts as balance staffs, pallet staffs, and so on, that turning for clocks is rather crowded out. It is true that both have much in common, but some of the lathe work involved in clock making is at least as highly specialised as that of the turning of a wristlet-watch balance staff.

One of the most informative parts of the book is the chapter on balances and balance-springs, for, not only is the production of balances dealt with, but the even more involved technique of both flat and overcoil balance springs is well covered.

So many other parts of this book could be selected for praise and comment that it is not possible to make a choice. Perhaps it would be fairest to say that the author has got as near as anyone to the impossible goal of compressing the whole field of horological work into the compass of a single volume. There, too, lies one of the few points of criticism, for to attempt such condensation seems a little unwise. That Mr. Gazeley has done so well is a tribute to his ability.

The illustrations are very well produced and the index deserves mention because of its completeness and accuracy, for the work involved in its preparation must have been tremendous. To sum up, this is a good book which will be of value to all who are interested in any form of timekeeper.

Letters to the Editor

(We do not hold ourselves responsible for the opinions of our correspondents)

SECOND LAW ANALYSIS

SIR,—Notwithstanding the "apparent complications" which Mr. Sara claims I introduced in my article, he does well to bring to our attention some misprints. I cannot do otherwise than acknowledge these graciously and accept full responsibility. The ratio $(T-T_0)/T \,.\, dQ$ appears and is wrongly printed on two occasions as $(T-T_0/T) \,.\, dQ$ in the section for which Mr. Sara provides an alternative. The suffix "0" has been omitted in the line immediately below equation (6) and also in equation (15).

It is true that the symbol "b" was used in the article for the availability whether this was given by $(E+p_0v-T_0s)$ or by $(H-T_0s)$. Keenan uses the symbol "b" for the quantity $(H-T_0s)$ only, but I allowed myself the privilege of using the symbol for the availability in a general sense. Perhaps this was not very thorough and I stand corrected here.

Mr. Sara is correct when he states that the constant pressure change which I considered is a special case when $p_1=p_0$. He writes: "In any other change at constant pressure, say, from p_1, T_1 to p_2, T_2, the change in availability will be

$$(E_1-T_0s_1+p_0v_1)-(E_2-T_0s_2+p_0v_2).$$"

This reduces to $(H_1-T_0s_1)-(H_2-T_0s_2)-(p_1-p_0)(v_1-v_2)$, where $p=p_1=p_2$, the third term representing the amount of work which has to be supplied from the surroundings to maintain the system in equilibrium.

The irreversibility was calculated from the equation

$$\left[\int\frac{T-T_0}{T}dQ-W\right]-\Delta[H-T_0s]$$

for flow processes. This equation is applicable in examples 1, 2 and 3 and not equation (15), which is applicable in the case of example 4.

I can assure Mr. Sara that his comments are valued, and I trust the purpose of the article has been achieved. I wish to point out that this work was carried out two years ago, when I investigated the subject first. A number of examples, without attendant theory, would not have been suitable for publication. Consequently I endeavoured to condense the theory as much as possible, but I should state in all fairness that anyone wishing to pursue the matter would be well advised to study Keenan's work. Since preparing the work which has been published I have extended the analysis to a steam generator and a combustion chamber, and I hope that this work may also be published. Of the application of the Second Law Analysis to the internal combustion engine I must say that I have carried out analyses of actual tests on an oil engine and a gas engine. The results are very promising, and I cannot endorse Mr. Sara's view in this connection. It is true that the analysis is difficult, since it is complicated by a chemical change. For this reason I might agree with Mr. Sara that "the method seems likely to be less useful."

EDWARD A. BRUGES

Glasgow, W.2, April 5th.

BOLTED CONNECTIONS IN STRUCTURES

SIR,—I note with much interest that the subject of high tensile bolting of structural connections has been given publicity in articles in your issues of March 19th and 26th. Your articles, together with the Bethlehem Steel Company's excellent brochure, "High-Strength Bolting for Structural Joints," and a number of other American reports and publications (e.g. T. R. Higgins, "Recent Developments in the Use of Carbon, Heat-Treated, High-Strength Bolts," Boston Society of Civil Engineers, July, 1951), show that the bolted structural connection is now being appreciated for what it is—the method *par excellence* for field assembly of structures of nearly all kinds and materials. It is so because of the obvious deficiencies, by comparison, of the known alternative methods—till recently upheld as the best—riveting and welding, and in earlier times (and still for some restricted military uses) pin connecting.

Welding, apparently simple, but really a complex metallurgical process, requires considerable skill, is expensive, needs plant and is hardly ideally suited to field application anywhere where little or no check can be made by X-rays, test sample welding, and so on. Riveting, more venerable and accepted, yet uses generally the least strong of the known forms of steel, and must use it in diameters governed by what is practicable in field tools and equipment. Thus the rivet diameter is chosen by tools rather than design. Both riveting and welding alike, as site work, destroy both heat-treatment of metal or rivet and galvanising, if any, and it is impossible fully to restore "shop" standard. This is because they are site heat processes. Further, they vary greatly in ease and reliability of application, according to materials, thickness of members joined, accuracy of holing and so on; e.g. joining any metal parts from 20 ga. sheet up to, say, 2in plate cover distinct crafts, and additionally so in light alloys.

With screwed friction-held cold jointing the whole position in field assembly is revolutionised. All materials (whether steel, light alloys, &c.) are "shop" work-hardened or tempered to best strength or properties obtainable with the material. Nothing is left to skill in the field except proper tightening, and this is not difficult if governed by torque wrenches, pneumatic or otherwise. With proportional selection of bolt or screw diameters the joining of the thickest or thinnest members can be dealt with alike—without any loss of heat-treatment or shop hardening of plates or bolts or damage to "hot-dip" galvanising. And though bolts, to be effective, are quite highly stressed by tightening, it is to be noted they are never subject to reversing or changing stress. However, it must be said that the "commercialising" of high-tensile bolting should not cause the wider design aspects of friction-held bolted jointing to be overlooked. For the main finding of the Americans is that the rivet is better replaced by a high-tensile bolt.

This is an advance over the days when the bolt was thought to be considerably inferior to the rivet, but in my article "Bolted Connections in Structures" (*Engineering*, May 7, 1948) still other aspects of friction-held connections are dealt with. These are worth mentioning again.

After making plate and bolt frictional experiments prompted by studying for many years the peculiar effectiveness of Callender-Hamilton bridging joints in four distinct scales of construction (models of one-twenty-fourth and one-eighth scales, half scale type "A" Callender-Hamilton bridging with ¾in diameter bolts, full-scale type "B" with 1¼in diameter bolts, and types "C" and "D" long-span railway bridging with 2in diameter bolts, the latter high tensile, the former mild steel—all being more or less in proportion as regards plate thicknesses and bolt diameters) it was noted that the joints did not slip if the bolts be reasonably well tightened. Evidently high frictional grip was present. It was possible to get it in two distinct ways, either by use of high-tensile bolts suitable in number, barrel and thread diameter and pitch of thread; or by use of mild steel large-diameter or "fat" bolts, as I usually describe them, giving equal pull to the high-tensile bolts because of having greater area.

My article showed the results of simple experiments on actual weathered galvanised Callender-Hamilton bridge members of type "B," set up as a "scissors" type machine, and the very simple design rule was put forward that, for mild steel bolts, the grip could be an immovable all-friction one for working loads if bolt diameter was three or more times the individual plate thicknesses passed through. The advantage of the mild steel bolt is that at the present time it is the cheaper and may be "spun galvanised" without strength impairment.

The object of this letter is to point out that large bolt or high frictional connections have been used in Callender-Hamilton bridges for many years. These bridges have carried some of the heaviest road traffic in England, as, for example, at the Westgate Bridge, Gloucester, the Southwark bridge approach spans in London, and on the Great North Road. In Holland they have been used as railway bridges carrying up to 120 trains a day.

It would be a pity to lose the dominant present position of this country in the use of bolted bridges. Only lack of knowledge of the part played by Callender-Hamilton bridging in war and in reconstruction could be the cause.

A. M. HAMILTON

London, S.W.1, March 29th.

Books Received

Temperature Measurement in Engineering. Vol. I. By H. D. Baker, E. A. Ryder and N. H. Baker. London: Chapman and Hall, Ltd., 37, Essex Street, W.C.2. Price 30s.

Electrical Engineering for Mining Students. By G. M. Harvey. London: Sir Isaac Pitman and Sons, Ltd., Pitman House, Parker Street, Kingsway, W.C.2. Price 15s.

Electrical Earthing and Accident Prevention. Consulting Editor, M. G. Say. London: George Newnes, Ltd., Tower House, Southampton Street, W.C.2. Price 25s.

Observation and Control of Dust

THE INSTITUTION OF MECHANICAL ENGINEERS

At a meeting of the Institution of Mechanical Engineers, last Friday, April 9th, the following paper was read :—

THE OBSERVATION AND CONTROL OF DUST AT PORTABLE ABRASIVE WHEELS AND PNEUMATIC CHISELS.

Part I : Dust Control Systems. By A. T. Holman, O.B.E.,* and E. B. James.†

Part II : Dust Observations. By W. B. Lawrie, M.Sc.‡

A new form of dust control has been devised for portable grinders. The method has been developed on a study of the aerodynamics of the system, as shown by cine-photographs of the moving dust clouds produced when grinding. It was known from earlier work that the dust of respirable size range did not follow the sparks thrown off by a grinding wheel. In consequence, the present work, which represents the first attempt to control dust through the portable wheel guard, was directed to the control of dust of the respirable size range. Still photographs of the dust clouds are included in the paper. For many years pneumatic chisels have been used without any method of dust control, although an increasing volume of medical evidence has shown that these tools produce dangerous dust in certain industries. In some cases stone masons have fitted small local exhaust ventilation hoods in front of the chisel, and a recent paper described an exhausted dressing bench for use in steel foundries. There are, however, many instances where the work cannot easily be placed on such a bench, and so a new dust control system has been fitted to a pneumatic chisel. In this design local exhaust ventilation is applied through a hollow chisel, and the dust is extracted through the pneumatic hammer. The main effort has been directed to the control of dust within the respirable size range, and the whole system was evolved as a result of the observation of the paths taken by the airborne dust produced by chipping. The moving dust clouds observed during the development stages have been photographed by a cine-camera, and the paper includes still photographs taken from the 35mm film negative.

Discussion

Dr. D. F. Galloway : Before one tackles a problem of this sort, the first thing to decide, I believe, is the significance of the problem that you are tackling—in other words, you do not want to spend £5 on solving a guinea question. Before coming along this evening I thought that I would look up a few figures to see whether I could get an idea of the significance of the problem that has been tackled in this investigation. Unfortunately, there are not any general figures for the British Isles, but I did manage to find in a report of one authority certain figures about foundries and various types of workshops, and I will quote one of them. In 1947, among casting dressers in steel foundries there were forty-seven workers who either died or were totally disabled by silicosis or tuberculosis arising directly from working conditions. That is just a part of the burden that we are bearing as a result of inadequate dust control ; and I think from that you can see that it is a matter of great import in terms of national economy and human suffering.

I also discovered that there has been a good deal of work on the medical side and that dusts have been classified, not only in size, but also in terms of their effect upon the workers. This can be used as an argument partly against the importance of the work if one wishes to argue that emery and certain other dusts are regarded as inert dusts—that is, dusts not giving rise to fibrous tissue or, in themselves, direct disease ; but I think it must be regarded as an established fact that these dusts, even if inert, are irritants and do predispose the worker to disease, and that, in addition to the severe cases resulting in death and total disablement, there will be a lot of lesser cases where the effect is that of lowering of health and lowering of efficiency ; so that overall there is a very big direct effect of inadequate dust control on the efficiency of the engineering industry. There are also many secondary effects. I will not bother to deal with more than one which came to my personal notice four or five years ago, when I noticed how a number of firms were being practically forced into reorganising those parts of their factories which deal with these dust-producing operations, particularly foundries, fettling shops, and so on ; and that this was largely because of the great difficulty in recruitment of labour. As older men who had grown up with these conditions were dying off, they found great difficulty in finding younger suitable people to replace them, and that particularly applied to apprentices. It was a difficult problem, because there is, and has been, a tendency to greater mechanism and a much more scientific approach to this side of production, and yet young men who might have studied it from the practical angle were being deterred because of the very unsatisfactory working conditions.

In conclusion, I should like to endorse what Mr. Lawrie said in presenting the paper and to express the hope that this excellent piece of work will result in other people following in the field, because I, too, regard it as a first step in the field and I am sure that it is a field which is well worth exploring. In looking into the field further, I think that we might bear in mind that one of the important things, in addition to controlling the dust, is possibly to explore ways of not creating so much respirable dust. I do not know whether there is any scope in this direction, but I put it to the authors. There is the question, in grinding in particular, of the grade of wheel, grid size and possibly things in technique which it might be possible to do to devise a way in which one could remove the material and not have so much dust in the respirable range—because apparently that is the dust which is most significant. Of course, the final challenge here is to better casting, so that we do not have to remove so much material in fettling, and I think that is important, not only from the point of view of the economics of dust control and the effect upon the worker, but also from the point of view of the ultimate cost of the product, because there is in these operations a very costly activity which has a very heavy direct labour charge.

Mr. C. Gresty (Wallsend-on-Tyne): I am exceedingly interested in this problem of dust, particularly as I am Chairman of the Cast Iron Research Association's Committee, which we call the Ventilation Atmospheres Committee, and, of course, I am also on the Joint Standing Committee on Conditions in Foundries. I should like to emphasise one statement to which the authors very rightly draw attention, namely, that if local exhaust ventilation systems are intended to collect dust, and not air, it is clear that they should be designed on dust flow. I think that statement sums up the position very well. I am not an engineer, but there is one question I should like to ask on that aspect. If one consistently draws air through a tool like a chisel—and I am not referring merely to the chisel end, but through the piston of the instrument as well—what happens ? Will there be very much extra wear and tear as a result of drawing through dusty air ?

Mr. H. Eccles : For a long time the trapping and collection of dust generated in factory processes have followed conventional lines whereby an exhaust draught applied to a hood of generous size and involving the removal of enormous quantities of air was utilised to collect relatively small quantities of dust. Such an arrangement, besides creating a heating problem owing to the extraction of a great deal of heat from the work room, often failed in its purpose by reason of the great loss in efficiency, as the point where the dust is generated or at which it comes within the influence of the exhaust draught is relatively remote from the hood. The investigations described in the present paper render portable tools independent of any external conditions in achieving a very substantial measure—not to place a too optimistic interpretation on the work—of dust control. The principle of bringing the dust generated in these portable operations under the influence of a stream of air moving with sufficient velocity to entrain the dust virtually at its point of origin is well exemplified in the case of the pneumatic chisel. The extremely low air consumption and the idea of the exhaust arrangements forming an integral part of the tool calling for no action on the part of the user to bring dust control into effective operation are certainly very attractive. I should like to ask the authors whether there is any tendency for the drill ports and ducts to choke up and therefore cease to function. Also, does not the provision of the ports and ducts on the drills reduce the useful life of the drills in that the amount of sharpening that can be carried out on them is limited ? As regards the abrasive wheel investigation, the measure of dust control achieved under the conditions mentioned appears to be very satisfactory. It is noted, however, that the extent of enclosure of the wheel would not permit it to be used on irregular and recessed surfaces, particularly if the irregularities are great or the recesses deep. In such a case the proportion of the wheel perimeter covered by the hood would be considerably reduced. It may be, however, since neither the port at the trailing edge of the hood nor the port next to it are included in the exhaust arrangements, that shortening of the hood by that amount would not seriously affect the dust control efficiency. Could the authors express any opinion on that point ?

Mr. W. H. White (Alvechurch, Birmingham) : I am a member of the Foundry Atmospheres Team of the British Cast Iron Research Association, and dust in foundries is, of course, our real job of work. What has struck me most in reading the paper, apart from the features already referred to by other speakers in the discussion, is the economic use of air—the small quantity of air needed to control the dust stream. I think it is generally felt that there is no doubt that the right method of controlling these dusts from abrasive wheels is as near the source as possible.

Mr. C. H. Jacobsen : As far as the application of the system to plants generally is concerned, a point was made earlier in the discussion about its relative cost as compared with the ordinary fan and large-diameter ducting, and so on. Using a turbo-exhauster such as is used on the high-vacuum industrial vacuum cleaner plants, the cost of a plant dealing with a number of machines in this way should be a little more, but not very much. Against that, the new type of plant will take up very much less space and it will have very much less effect on the removal

* Holman Bros., Ltd., Camborne, England.
† Research Division, Holman Bros., Ltd., Camborne, England.
‡ H.M. Engineering Inspector of Factories.

of tainted air from the work rooms ; in other words, it will not be necessary to spend so much on coal or on whatever other fuel is used for heating the air.

What is the effect of the wear on the wheel ? When the wheel is worn down appreciably—because foundrymen do not like throwing away wheels too quickly—what influence will it have on the efficiency of extraction in the normal method of working, where the wheel is moved about fairly quickly over the top of the casting or round the corners of it ? I think that the experiments might be continued in order to show what reduction in the size of the hood could be successfully realised without losing the efficient control of the dust.

Two speakers have asked how the life of the chisel would be influenced by this device of extracting dust through a hollow chisel. I should like to suggest that the life of the chisel is utterly unimportant relative to the life of the workman using it !

Mr. Haywood : I have just returned from a conference of the Institute of Physics at Nottingham on the physics of particle size analysis. The physics of dust particle size measurement — particle counting — has reached a very high stage of efficiency. I should like to tell the authors that there is a growing feeling that the physics of particle size measurement and the mathematics of motion of particles in air has now reached a stage where the accuracy is ample and in many cases more than ample for the purpose required, which is the application of that knowledge to actual dust control efforts. I think it is now being realised that the next stage of development, which will be a culmination of the scientists' and the engineers' work, with increasing predominance given to the work of the engineers, will be the application stage ; and I should like simply to say that I have seen that all those people are realising the immediate importance of that application work.

Mr. Duff : We have been given information on the range of air consumption for dust extraction on 5in and 6in wheels. I wonder whether the authors could give us any idea of comparable figures on larger wheels, going into the swing-frame grinder range, of 18in, 24in and so on ?

Mr. M. J. Sargeant : I have seen quite a number of installations in factories where there were portable machines for shot-blasting and they had an evacuant system on them. I have assumed in the past that these were perfectly safe ; but, having seen some of the suggestions in the paper, I should like to ask the authors whether they do in fact also give off dust ?

Mr. Sharp : One problem that I see is when the chisel requires re-sharpening. The time will come, of course, when the cutting edge will be ground back to the air ducts, and perhaps thought will be given to some other method of extracting the air which runs along the chisel body. Perhaps some method of covering the chisel could be evolved. One of my colleagues has drawn my attention to the possibility that the air holes in the chisel could perhaps be placed higher up in the body. I should like to ask the authors whether any work has been done on the shape of the cutting edge. Whereas the general pneumatic tool, the double-hammer chisel, is by far and away the most useful tool, have the authors any opinion as to whether a single-hammer cutting edge would perhaps raise less dust than the standard double-hammer ?

Mr. James and Mr. Lawrie replied briefly and the meeting ended.

Radiochemical Centre, Amersham

New buildings, specially designed for the production of radioactive isotopes at the Radiochemical Centre, Amersham, were opened on Thursday, April 8th, by Sir Henry Dale, O.M., F.R.S., New chemical production plants are installed, together with improved facilities for dispensing, packing and dispatching, to meet the growing demand for radioactive materials. An outline of the manufacturing facilities is given here.

SINCE the formation of the Radiochemical Centre in 1946 the market for its products has increased to such an extent as to require production on a commercial as distinct from a laboratory scale. Hitherto the output of radioactive isotopes from Harwell and Amersham has been obtained from simple laboratory apparatus requiring a certain amount of direct manipulation and housed in general purpose buildings. These methods have served their purpose ; but, to meet the current demand for some of the more important isotopes, it has become necessary to install individual chemical plants for each material, the plants being completely screened and remotely operated and installed in buildings specially designed for this purpose.

A recent visit to the Radiochemical Centre gave us the opportunity to see something of these new buildings and plant the day before the formal opening by Sir Henry Dale. Our description of the new installation is prefaced by a brief outline of the history, growth and functions of the Centre.

The Radiochemical Centre was formed by the Ministry of Supply on November 1, 1946, as a trading establishment for processing and distributing radioactive materials ; the main buildings were put up in 1947–48 adjoining the old laboratories of Thorium, Ltd., which had occupied the site since 1940. In 1950 the Centre became a branch of the Atomic Energy Research Establishment under the overall direction of Sir John Cockcroft, and the policy of concentrating the chemical production of radioactive isotopes at Amersham was put into practice.

In the past four years the value of the materials supplied from Amersham has more than trebled, reaching a total of £114,000 in 1953. About one-third of the output was exported and more than one-third of the exports were made to dollar markets. Sales were made to thirty-six countries, the principal buyers being the U.S.A., Canada, Germany, France, and Sweden.

During March, 1954, there was a sharp increase in deliveries from Amersham over previous months because of the inclusion of radioactive phosphorus and iodine, which had previously been supplied by the Isotope Division at Harwell ; in other respects the growth in demand continues steadily. The manager of the Radiochemical Centre is Dr. P. Grove. He has a total staff of 150, of whom seventy-five are classed as scientific and technical and forty-five industrial, while the rest are administrative.

Products and Services

The products of the Centre fall broadly into two classes : radiation sources, and radioactive chemicals (" labelled compounds "). There is a great variety of these materials, some twenty different isotopes and several hundred compounds, and they are described in the catalogue *Radioactive Materials*, published in 1953 by the Ministry of Supply for the Radiochemical Centre.

The most versatile single isotope is radioactive carbon, carbon-14, which is made by irradiating nitrogen with neutrons. The target material (aluminium nitride) is prepared at Amersham, sealed in aluminium cans, and sent to the production piles at Windscale, to be irradiated for about a year. The active material is then returned to Amersham and carbon-14 extracted from it. Because of the long period of irradiation and the need for devising a target material which will withstand the rigorous conditions in the pile for that period, the building of stocks of carbon-14 has been a laborious process ; annual production is now sufficient to meet the demand (about 10 curies).

In its simplest form (carbonate) carbon-14 is only of limited interest, and the real need is for the widest possible range of carbon compounds. The organic group under Dr. J. R. Catch has worked for the past five years on the synthesis of these compounds, and about one hundred of them are now available. Most of them have been made by chemical synthesis, but biological methods are now being used increasingly. The radioactive sugars, for example, are being made by both methods ; they are obtained uniformly labelled with carbon-14 by photo-synthesis in tobacco leaves, and specifically labelled in one part of the molecule by chemical synthesis. The common green alga (*Chlorella vulgaris*) has been used very successfully to produce protein generally labelled with carbon-14, and from this a number of amino-acids of particular interest to biochemists have been separated.

About a dozen other " separated isotopes " are being made as routine products, usually by extraction from materials irradiated in B.E.P.O. at Harwell, but occasionally also by cyclotron irradiation. Fortunately, the two isotopes in greatest demand for medical purposes, iodine-131 and phosphorus-32, can be used in the simple chemical form in which they are first extracted ; but the general trend is towards supplying each isotope in a variety of chemical compounds

Fig. 1—New Buildings for Isotope Production at the Radiochemical Centre

comparable with the normal range of chemical laboratory reagents. A group of chemists under Dr. J. C. Charlton is developing this part of the work.

Waste solutions of fission products from which the plutonium and uranium have been removed are received at Amersham from the production factories in the North of England. They are the raw materials from which several important isotopes are separated. Under the supervision of Mr. P. E. Carter two production units have recently been built which will produce about 100 curies each year of strontium-90 and cæsium-137. But before these fission products or similar isotopes can be generally useful in industrial applications they must be incorporated in such forms that they are safe and convenient to use, and cannot become a source of radioactive contamination. Considerable effort has therefore been devoted to producing radiation sources in standard physical forms. Thus silver foils containing strontium-90, for example, are now being widely used industrially in such instruments as thickness gauges. Other industrial uses include static eliminators, position indicators and initiators in gas discharge tubes.

Until five years ago nearly all the work at Amersham was with the natural radioactive elements. There is still considerable academic interest in the elements themselves, and the medical requirements for radium appliances and radon seeds have increased. The natural radio elements section under Mr. L. C. Myerscough has manufactured very large numbers of these sources, and care has been taken to maintain their quality. During the last five years about 12,500 radium needles have been manufactured, containing 97 grammes of radium in all.

New Buildings and Production Plants

The present building programme provides for eight new buildings, four of which have so far been erected (Fig. 1). Each building is being used for a group of processes of similar character. In one there is the separation of fission products ; in another the production of radioactive iodine, phosphorus, and other isotopes. Another is used as a dispensary for radioactive solutions, and the fourth is for biological processes.

Each building consists of a single room having a floor area of 900 square feet, which is clear of any permanent fittings. The four buildings are well separated from each other, so as to reduce the radiation field between them, and to allow access for heavy vehicles carrying supplies of radioactive raw materials. Each building is provided with all the services necessary for conducting radioactive processes efficiently and safely—particularly ventilation and special drainage for radioactive effluent—and they are arranged to serve six production plants in each room. Above the entrance of each building (Fig. 1) there is a wooden glass-fronted structure to house the ventilating plant.

Installation of the chemical production plants has been going on for about six months and is nearly half completed. Five units are in operation. The processes which have been used hitherto for separating radioactive isotopes from irradiated materials have not generally been found suitable for scaling up, and it has therefore been necessary to develop new methods which are basically suited to operation by remote control. The design of each plant has to meet the following general requirements : complete screening against radiation ; avoidance of any direct handling of active materials ; effective control of gaseous, liquid and solid effluent. Screening is provided by walls of lead and concrete bricks, and all equipment which may become radioactive is contained in sealed compartments ; so that in future, if modifications are required, each plant can be completely dismantled without interference with the structure of the building. Most of the equipment has been made in the Centre's workshops.

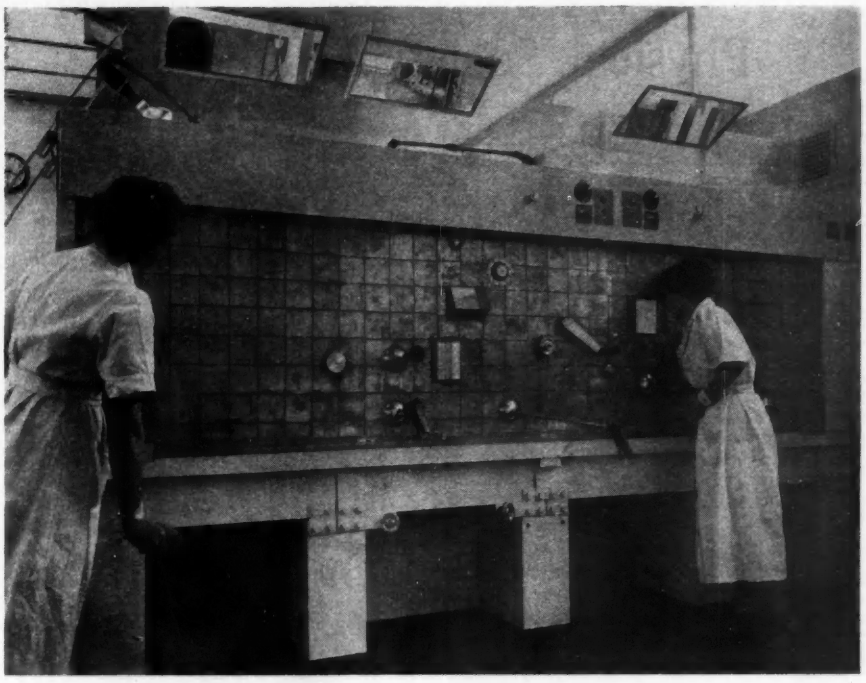


Fig. 3—Dispensary for Gamma-Emitting Isotopes

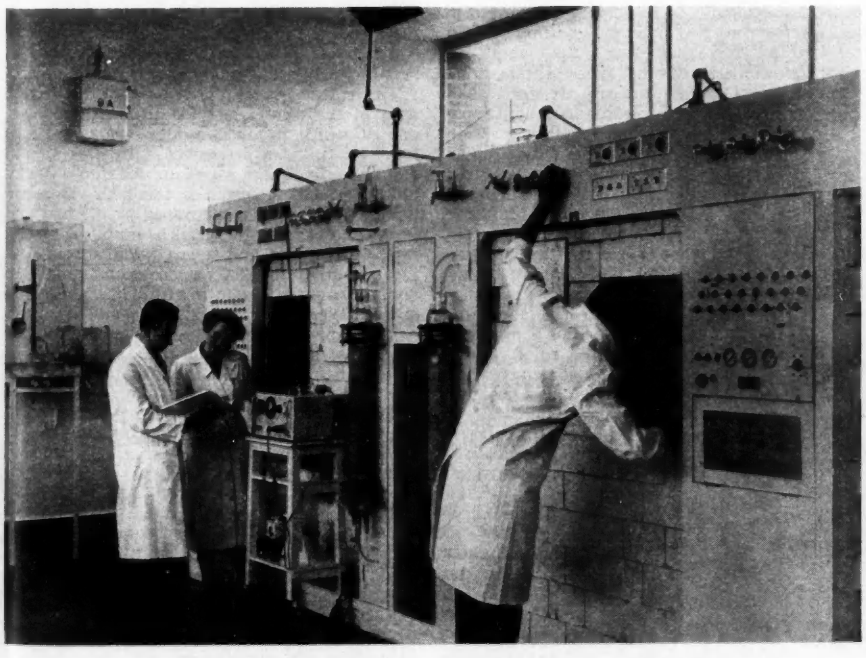


Fig. 2—Laboratory for Separation of Radioactive Isotopes from Fission Products

Views of production plants in two of the laboratories are reproduced herewith. In Fig. 2 we show an installation consisting of two screened production plants for the separation of radioactive isotopes from uranium fission products. One of the plants produces strontium-90 by precipitation from nitric acid ; the other plant produces cæsium-137 by precipitation of cæsium phosphotungstate. The two units side by side are enclosed by an 18in concrete shield.

In these and in other production processes at Amersham glass is used throughout for the vessels containing the reagents and the communicating pipework, valves, &c. Magnetic material is incorporated in the valve bodies and remote operation is effected through solenoids.

In another of the new buildings there are plants for the production of iodine-131 and phosphorus-32 by chemical separation from materials irradiated in the Harwell pile. In the case of iodine-131 screening is provided in front by a 4in thickness of lead made up of interlocking bricks and, at the back, by 18in of concrete. The process takes approximately two days and two batches each of 4 curies are produced per week. In the case of phosphorus-32 adequate screening is provided by 1in thickness of " Perspex," and two batches totalling 3 curies per week are produced.

Another building houses a dispensary (Fig. 3) for solutions of radioactive isotopes for medical use. In this plant the operations of pipetting, assaying, bottling, capping, sterilising, and check measuring are carried out, the liquids and containers being handled remotely by mechanical manipulators, such as can be seen in Fig. 3. The " bomb " containing the liquid is loaded through the bottom of the left hand of the screened enclosure, with the help of a combined trolley and jack, which can be seen more clearly in Fig. 1. The operations enumerated above are carried out in one or other of three chambers into which the screened plant is divided and the material is transported from one chamber to the other on rails by the operation of handwheels. Screening is provided by a 4in wall of interlocking lead bricks at the front and an 18in concrete wall at the back. The operations are viewed from the front of the plant through 6in lead glass blocks and mirrors.

Physical Society Exhibition

No. II—(*Continued from page 526, April 9th*)

THE annual exhibition of the Physical Society ended at the Imperial College of Science and Technology on Tuesday last. Some of the exhibits are described in the following review of the exhibition.

Mullard, Ltd.

The scientific and industrial apparatus shown by Mullard, Ltd., Century House, Shaftesbury Avenue, London, W.C.2, included a high-stability variable-frequency oscillator. This equipment, which was described in our issue of March 12, 1954, page 404, allows the frequencies of transmitters in the h.f. broadcast band to be made smoothly variable and to comply with the regulations of the International Telecommunications Union, which require that deviations from the nominal frequency value should be less than $\pm 0{\cdot}003$ per cent.

To maintain this degree of stability it is usual to resort to crystal control, which has the disadvantage that new crystals must be obtained when channels are reallocated. The Mullard variable-frequency oscillator avoids this difficulty. The oscillator output, which is variable between the limits 1 to 1·7 Mc/s, is passed through a tuned buffer amplifier to a frequency multiplier that produces either the second (2–3·4 Mc/s) or third (3–5·1 Mc/s) harmonic as required. A final wideband power amplifier delivers 0·5W into 70 ohms.

The oscillator proper is housed in a simple oven whose temperature is controlled to ± 1 deg. Cent. This degree of temperature control, in conjunction with high-stability components (notably the Mullard precision variable capacitor), is adequate to keep frequency variations within the required limits. Frequency is set up by rotating the precision variable capacitor through a slow-motion drive, which may be locked. A vernier inductance trimmer is used for the final adjustment. During this process the oscillator frequency is continually measured by a displaying frequency monitor, and in this way it is possible to set up to any frequency in the range within a tolerance of $\pm 0{\cdot}0001$ per cent in a few moments. The frequency monitor may be used to check the frequency wherever necessary, and is, of course, available when the other oscillators in a transmitting station require adjustment.

Another instrument shown by Mullard, Ltd., was a transistor curve tracer, designed to trace characteristics of point contact and junction transistors. With this instrument (Fig. 7) the collector characteristics may be plotted under grounded base or grounded emitter conditions. A current is passed through two terminals of the transistor and the voltage across these terminals is plotted against the sweep current. The current through the other terminals of the transistor is maintained constant during the sweep, and increased between each sweep by a controlled amount. In this way a complete family of characteristics is traced. Between each complete set of characteristics the co-ordinating axes are traced.

A wide range of output currents is provided to cover all existing types of transistor, including small power junction transistors. The characteristics may be plotted beyond the normal static limits, without damage to the transistor, due to the pulsed waveforms employed in the sweep circuits.

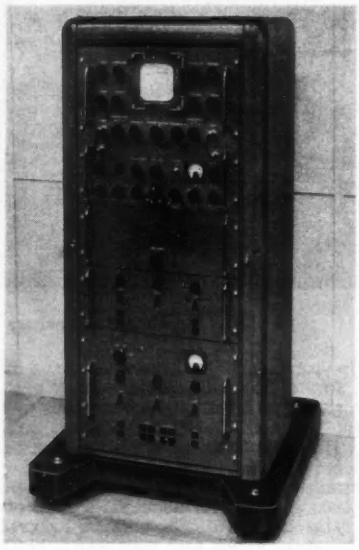


Fig. 7—Transistor Curve Tracer—Mullard

The transistor may be enclosed in an oven, or light box, thus enabling the effect of heat or light on the complete family of characteristics to be measured. The instrument facilitates rapid measuring or checking of characteristics, and an attached camera enables a permanent record of the characteristics to be made. The waveform generator and display units may be employed in conjunction with alternative output units, to trace characteristics of other types of transistors, the instrument being primarily designed as a research tool, with maximum flexibility.

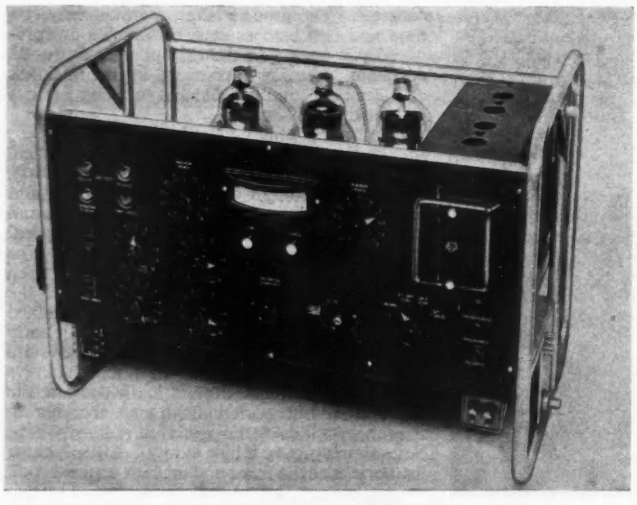


Fig. 6—Resistance Furnace Temperature Controller—Mullard

On the same stand a demonstration was given to show how the temperature of a small resistance furnace could be controlled to better than 0·2 deg. Cent. by a signal derived from a thermocouple. The apparatus used for this demonstration consisted of a resistance furnace temperature controller (Fig. 6) and programme unit.

On this temperature controller the required temperature (up to 1100 deg. Cent.) is set up through a potentiometer calibrated directly in millivolts and the power input to the furnace is regulated by thyratrons. There is provision in the controller for proportional, differential and integral terms.

When a programme unit is used in conjunction with this controller the required furnace temperature is coded and punched on a paper tape. This coded information is translated and compared with a reference signal from the thermocouple in the furnace. The error signal resulting from this comparison is fed into the temperature controller in the normal way. Accordingly, temperatures up to 1000 deg. Cent. can be programmed for long or short periods in steps of 1 deg. Cent.

The British Thomson-Houston Company, Ltd.

An integrating manometer shown by the British Thomson-Houston Company, Ltd., Rugby, takes the form of a device in which the pressure to be integrated with respect to time is applied to the inside of a bellows. The bellows is constrained by a number of 1-mil "Eureka" wires, which act as a strain gauge. These wires form components of a Wheatstone bridge, the other arms of which are mounted inside the bellows to ensure temperature compensation. If direct current is supplied to the bridge so formed, the out-of-balance voltage is proportional to the pressure. Outputs of 2mV per inch of water are readily available.

If the bridge is supplied with alternating current, and a transformer with low secondary resistance is placed across the diagonal, the output from this transformer can be rectified mechanically, and applied to a fluxmeter; in this way the fluxmeter circuit resistance is kept low, and the damping high. The fluxmeter measures mV per second, and deflections proportional to the pressure integrals are derived. Sensitivities of 1 radian per inch of water per second are said to be obtainable.

On the same stand there was shown an electronic clearance monitor which has been developed for the measurement of axial or tip clearances between turbine blades and casings. The monitor operates on the principle of the condenser microphone and the quantity measured is the change in capacitance as the blades pass a fixed probe on the machine casing—a change which is a function of the clearance between the blades and the stator. The monitor works equally well on irregularities such as holes on the disc carrying the blades. Radial or axial clearances from about 0 to 150 mil can be measured by this means. Vibration amplitudes from about 10 c/s upwards can also be measured by the monitor.

Atomic Weapons Research Establishment

Devices developed for high-speed photography were shown by the Atomic Weapons Research Establishment, Fort Halstead, Kent. They included an automatic exposure control for a Kerr cell ciné camera. This apparatus controls the exposure time of the camera in the range of $0{\cdot}05\,\mu$ sec to $1{\cdot}0\,\mu$ sec, depending on the brightness of the subject being photographed.

The square waves derived from the trigger strip of the camera are fed to two amplifiers, one of which produces a pulse whose width is fixed at 0·05 microseconds. In the second amplifier, the square waves are fed into a Miller integrator, and the resulting trangular waves are limited at two levels determined by the bias and grid base of the next stage. The output from this stage is amplified and squared, and mixed with the output of the 0·05 microsecond amplifier, and the mixed waveform, further limited and amplified, provides the drive for the Kerr cell.

Variation of pulse width is obtained by using the output of a photo-multiplier, amplified, and fed through a cathode follower to adjust the bias of the limiting stage according to the surface brilliance of the object being photographed. The apparatus was exhibited in conjunction with an engineered model of the Kerr cell ciné camera, whose prototype was shown in the 1951 exhibition.

The A.W.R.E. also showed a high-speed streak camera which is a synchronised camera of aperture f/11 with a maximum writing speed of 20mm per microsecond and a resolution in the film plane of twenty lines per millimetre.

The optical system has a primary lens with fine adjustment to provide an image in the plane of a calibrated variable slit over the range of working distances 30in to infinity. By means

of a secondary lens and a rotating mirror, an image of the slit is formed on the film surface. The image of the primary entrance pupil in the secondary lens is arranged to be accommodated by the rotating mirror over the film quadrant in use.

A compressed air turbine drives the mirror at 240,000 r.p.m. To obtain this speed, it is necessary to reduce the pressure in the camera body or to provide an atmosphere of helium. To prevent overspeeding with consequent risk of mirror fracture, an automatic electromagnetic brake is incorporated ; this brake also provides accurate control of the turbine speed. Photo-multipliers are fitted to provide time checks and to ensure synchronisation of the event and of other monitoring equipment with the camera.

Atomic Energy Research Establishment

The Atomic Energy Research Establishment, Harwell, showed a very small-scale working model of a form of electromagnetic pump which can be used for pumping liquid metals such as mercury or sodium. This model constitutes an excellent demonstration of the left-hand, three-finger rule used to determine the direction of motion of a conductor carrying a current in a magnetic field. Heavy direct current is passed between electrodes through the mercury in the pumping channel and is supplied from an external rectifier source. The magnetic field is provided at right angles to this current, by a pair of magnetron magnets. Interaction between the current and magnetic field produces a force and, hence, motion of the liquid in the third direction. To compensate for armature reaction the current which travels through the mercury is brought back on either side of the pumping channel, by copper conductors. There are no moving parts in the pump so that maintenance is negligible. Liquid metal can be pumped at a high temperature since all parts can be metallic. Efficiency can be reasonably high, but a large direct current is required at a very low voltage.

The A.E.R.E. also showed a mobile monitor for beryllium which has been developed to give an instantaneous indication of the presence of a breathing hazard due to beryllium or its compounds. The air to be tested is drawn through a spark between copper electrodes, and the light resulting from excitation of the particles of beryllium or its compounds is, after passage through a monochrometer, observed by a photo-multiplier whose output, suitably amplified, produces a chart record. There is no interference from common elements, but because of the effect of particle size, the record does not furnish a precise quantitative figure. The instrument has proved of value in laboratory uses and factory production of the metal and its compounds.

Another exhibit demonstrated recent developments in fission chambers. A series of fission chambers have been designed mainly to meet reactor instrumentation requirements. The main object has been to contain in as small a volume as possible the maximum amount of fissionable material in the form of an oxide film, of about 1 mg per square centimetre thickness. In one instance, this objective has been achieved by depositing the active material on to a set of closely spaced interleaved coaxial nickel cylinders which form the electrodes of the chamber.

The fissionable materials so far employed include natural uranium and uranium enriched or depleted in U235. Pure argon at 10 atmospheres pressure has been the filling gas in all the chambers so far constructed. The chambers are normally operated at a potential difference of 300–500V, with sufficiently low time constants to allow electron collection only.

Elliott Brothers (London), Ltd.

Computing equipment formed part of the display shown by Elliott Brothers (London), Ltd., Century Works, Lewisham, London, S.E.13. As a result of experience gained from building digital computing machines this company has developed the practice of constructing such machines from a number of standard circuit assemblies or "packages"—a method of construction which facilitates fault detection and servicing.

"Storage" is obtained in small packages by making use of the phenomenon of magneto-striction in nickel wire : for example, a delay line of 100 microseconds serves as a register for one "word" of 3 microsecond pulses, and delay line stores having a greater capacity are available. Where intermediate access is required cathode-ray tube stores are used and magnetic disc stores have been developed as an alternative to the more common drum for the principal store of a computer. Examples of the package units and stores were shown.

The company also exhibited a small analogue computer built up of standardised component assemblies.

All the electronic circuits are accommodated in chassis of simple construction and standard size, and fifty-six of them can be accommodated in one cabinet. The cabinets are prewired with supplies and monitoring detection and display equipment, and provided with cartridge clips for standard scaling-factor resistors and coefficient potentiometers on the front panels. It is only necessary to insert plug leads to set up an equation. The basic d.c. amplifier is of hybrid design and can be supplied with a zero error correcting unit of either the "chopper" relay or magnetic inverter types ; this amplifier is used for the operations of addition, integration and differentiation. Multiplication is carried out either with a diode chain multiplier or an electric servo/potentiometer system.

Among the other components available are a plotting table, a series of electro-mechanical servo components and sine/cosine potentiometers ; the latter will operate with an accuracy to within 0·1 per cent at up to 12 c/s when a hydraulic drive is employed.

Among the temperature-measuring instruments shown on this stand was a high-speed temperature indicator which has been developed for use in applications where rapid response to temperature changes is of importance. It is particularly suitable for multi-point installations where many variables need to be logged at a central control station, with the aid of a single instrument and switch.

It employs resistance thermometers of the normal platinum wound design connected to an a.c. fed Wheatstone bridge network. The out-of-balance e.m.f. derived from the bridge circuit is fed to a high-gain amplifier which in turn energises the reference phase of a two-phase servomotor. This servomotor drives the pointer to which is directly coupled a high-precision cam-corrected potentiometer until balance is restored. Full-scale travel is effected in one second for full-scale interval of 50 deg. Cent. or greater. Shorter temperature ranges spread over the full scale, can be accommodated involving a small increase of travel period.

Research Laboratories of The General Electric Company, Ltd.

A recorder with two variables for plotting valve- and synchro-characteristics was shown by the research laboratories of The General Electric Company, Ltd., Wembley, Middlesex.

This recorder is designed to accept d.c. input voltages proportional to two variables and to plot a curve showing the relationship between these variables. Recording is done on a 40cm by 30cm chart paper on a drum driven by a position control servo system. A ball-point pen is moved across the surface of the paper along the drum axis, by similar servo system. To lift the pen from the paper there is a solenoid-operated mechanism.

It is stated that the dead zone is less than $\pm 0 \cdot 2$mm, that the linearity is within $\pm 0 \cdot 2$ per cent, and that the scaling accuracy (which relies on voltage regulating tubes) can be within ± 1 per cent. Depending on the gear ratio in use, the speed of response is equivalent to the completion of a 35cm step in 0·5 seconds to 0·7 seconds.

The equipment was demonstrated with an attachment for plotting valve characteristics and for determining the accuracy of resolver synchros by a comparison method.

W. G. Pye and Co., Ltd.

The prototype of a small battery-operated pH meter measuring 7in by 5in by 3in was shown by W. G. Pye and Co., Ltd., Cambridge. This instrument (Fig. 8) is intended both for laboratory use, where the expense of a true-laboratory instrument cannot be justified, and for plant and field testing where robustness, portability and independence from mains supply are the main requirements. It has a range of 2–12 pH displayed on a 3½in length scale divided into fifty divisions ; each division represents 0·2 pH and the discrimination (one-quarter division) is 0·05 pH. Four sub-miniature valves are used in the circuit, which is stable in operation and independent of valve and component changes. A characteristic of the circuit is that it permits the use of very robust (high-resistance) glass electrode. Miniature batteries, three of 1·35V and three of 22·5V provide a life of 360 hours and 600–800 hours respectively. Temperature

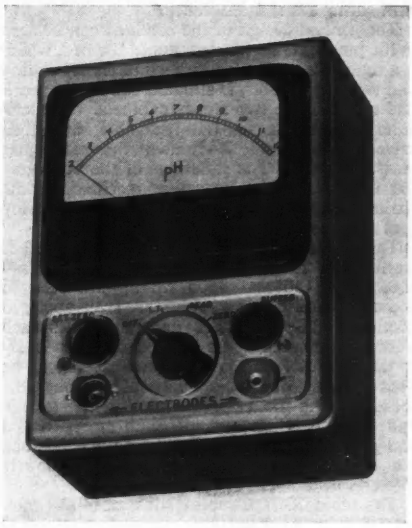


Fig. 8—Miniature pH Meter—Pye

compensation is effected by way of manual controls accessible at the rear.

The company also gave a demonstration of the use of a pH meter as an insulation tester, the principle of the method being that if a known voltage is applied to an unknown high resistance in series with a standard resistance, the voltage appearing across the standard resistance will be inversely proportional to the high resistance. Because of the very high input resistance of the company's pH meter (Cat. No. 11066), the standard resistance may be at least 1000 megohms and a voltage of 1mV can be readily detected. The demonstration showed a pH meter used in this way with a scale directly calibrated in insulation resistance ; the full-scale value was 10^{-12} ohms and a resistance of 10^{-15} ohms could be detected.

(To be concluded)

"Comet" Disaster

On Thursday evening of last week another "Comet" aircraft crashed into the sea shortly after taking off from Rome, with the loss of life of all on board. This disaster was not apparently witnessed by anyone and no distress signal was received. As with the "Comet" crash near Calcutta and that at Elba, contact with the aircraft was again lost shortly after take-off whilst the machine was approaching its cruising altitude. Evidence of its plunge was afforded by an oil patch 35 miles north of Stromboli, and five bodies and small pieces of wreckage have been recovered from an area estimated to be as large as 20 square miles. All "Comets" were once again grounded and their airworthiness certificates suspended. Although sabotage is still not excluded as a possible cause, technical opinion seems to be inclining to the existence of an unusual combination of temperature and stress factors which might arise using a gas turbine during the transient air pressure and temperature conditions when climbing at relatively slow speeds. A further series of full-scale flying tests is to be financed by the Ministry of Supply, in which it is hoped that equipment will be devised sensitive or quick enough to detect any manifestation of abnormality in time to arrest it.

Copy Turning Lathe

DETAILS have now been issued of a new copy turning lathe known as the "Carbitracer," which is being made by Alfred Herbert, Ltd., of Coventry. It is designed for copy turning shafts up to 48in long and 6in diameter, using a workpiece or a template as a master. The machine is designed for use with a single-point tipped tool and its main saddle and copying mechanism are situated above the work, thus eliminating swarf interference.

The general design of the machine can be seen in the photographs we reproduce. Its bed, which is a rigid box casting well ribbed to resist bending and twisting stresses, is situated behind the work and mounted on two sturdy cabinets. The left-hand cabinet carries the headstock and feed drive gearing and it houses the main and blower motors. The slideways of the bed carry the saddle and its hydraulic mechanism, the master template or model tailstocks, the recessing tool slides and the main tailstock.

The headstock provides eight spindle speeds from 250 to 1500 r.p.m. Four of these speeds—410, 530, 1160 and 1500 r.p.m.—are selected through sliding gears, and a lever-operated friction multi-plate clutch change enables each of these four speeds to be reduced instantaneously in the ratio of 1·67 : 1. Thus two speeds can be used for any one set-up without stopping the spindle. The main spindle is mounted in ball and roller bearings and all gears are hardened and ground. All essential parts of the headstock are automatically lubricated by continuously filtered oil.

The main 20 h.p. motor runs at 1400 r.p.m. and drives the headstock through vee ropes. Push buttons on the headstock provide for starting, stopping and inching. Quick stopping of the spindle is ensured by a plugging relay operated automatically when a push button is pressed. All the electrical equipment is contained in the cabinet at the right-hand end of the machine. Push buttons situated on this cabinet are used for starting and stopping the blower motor and hydraulic pump unit. The blower motor cools the main motor and makes possible frequent starting and stopping without overheating, an important factor when operating the machine on short time cycle operations.

The automatic feeds to the saddle are provided by sliding gears in the headstock and a rotating screw which is covered by a sliding steel guard. The three feed rates available are 60, 80 and 120 cuts per inch, and they are selected by the small lever beneath the push-button panel on the headstock. A safety slipping clutch is incorporated in the feed drive, together with the firm's "Chiprupter" arrangement, which enables the feed to be momentarily stopped as required to break long turnings into short, safe lengths. The automatic feed is in the direction of the headstock only and is engaged and disengaged by a lever on the saddle. Automatic trip is provided by a collar which can be adjusted on a shaft on top of and parallel to the bed, to enable the feed to be tripped at the end of the cut.

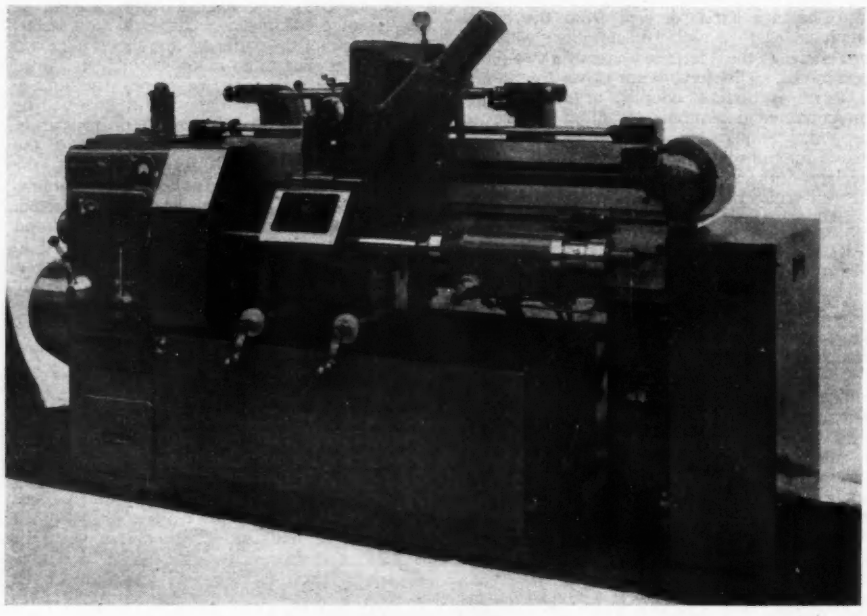
Quick-power traverse to the saddle is provided and a hand traverse can be operated at either end of the machine for setting purposes.

The saddle, as can be seen in one of the illustrations, carries an angular tool slide on which is mounted the hydraulic cylinder and tracer unit. This slide is provided with rapid traverse in both directions controlled by a small lever. The tool slide carries a detachable tool post and is provided with a vertical adjustment; a graduated dial reading to 0·001in assists in accurate setting of the height of the tool from the work. An adjustable stop is provided to the tool slide.

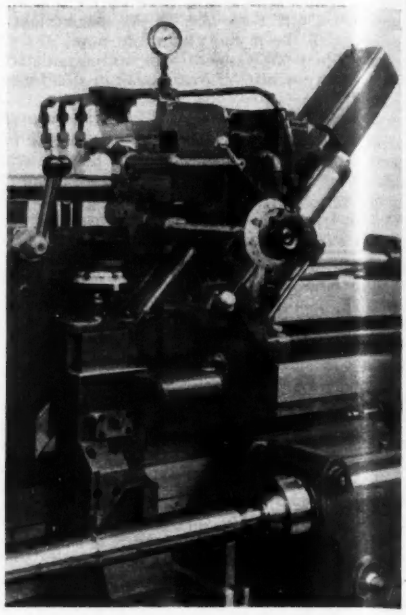
A stop on the slide can be adjusted by a fluted knob and it can be set with the help of a graduated dial which reads to 0·002in per division of vertical adjustment, to limit the downward travel of the slide. This arrangement enables parallel cuts to be taken before the tracer unit controls the movement of the tool slide. The angular slide returns to fully up position on the rapid reverse movement.

The profiling system fitted to this machine is of the "Metrovick" hydraulic design and in operation the angular slide rises and falls under the control of the tracer unit whilst the saddle traverses continuously to the pre-set tripping point. The stylus bears lightly on the profile of the master and is attached to the pilot valve unit which controls the flow of the hydraulic oil to the operating piston and cylinder actuating the slide.

The tracer is tipped with "Ardoloy" to provide long life and the tracer lever is mounted on ball bearings and is so designed as to ensure a sensitive motion even when traversed up to a square shoulder. A safety device is fitted to this lever to prevent damage to the unit if the saddle is over-traversed in any direction. A manually operated valve permits the tool to be withdrawn from the workpiece whenever required.



Hydraulic Copy Turning Lathe



Angular Tool Slide Fitted with Hydraulic Profiling Mechanism

The hydraulic pumping unit is mounted on a bracket at the rear of the machine and all flexible pipes are at the rear, safe from possible damage by the chips.

The two tailstocks on top of the machine bed which carry the master template are in a position where there is little likelihood of swarf interfering with the contact between the stylus and template. The tailstocks are adjustable along the bed and each is provided with a clamping lever. The left-hand tailstock has a spring-loaded centre with screw adjustment, whilst the other has screw adjustment and a graduated dial for accurate positioning of the model. The centre itself in the left-hand tailstock also has means of vertical adjustment for obtaining the correct alignment of the model. Models can be used for all copy turning up to 4in diameter on the machine and above this size templates are required.

A heavily designed work tailstock is mounted on the vee slideways of the bed, and can be traversed by a rack and pinion and securely locked in any position. The tailstock sleeve which carries the running centre is hydraulically controlled and the hydraulic pressure allows for work expansion, whilst a non-return valve prevents fall of pressure in the cylinder should the line pressure fail. The running centre is mounted in an adjustable roller bearing, end thrust being taken on a ball thrust race.

Two forming or recessing slides can be positioned and locked on the same vee slideway as the hydraulic tailstock in any position between the tailstock and headstock. Each of these slides carries a toolpost and is provided with a horizontal screw adjustment for setting of the tools. Vertical feed of the tool slide is transmitted through a screw and bevel gearing and pilot wheel, a graduated dial being provided for accurate control of the depth of cut.

Two adjustable vee rests are provided for supporting the work when loading, one rest being bolted to each of the recessing slides. The lathe can be supplied with either a work driver of driving-dog design, with two carriers covering all sizes of bars up to 6in diameter or a "Coventry" three-jaw chuck. Sliding guards fitted with a "Triplex" glass window are supplied with the machine to protect the operator from flying chips.

BURNING OF COKE BREEZE.—John Thompson Water Tube Boilers, Ltd., Wolverhampton, has published a pamphlet entitled "A Coke Breeze Burning System," which contains a note upon the nature of coke breeze and a brief outline, together with an illustration, of the down-draught system of burning it.

Work of the U.S. Atomic Energy Commission

(By Our American Correspondent)

THE fifteenth bi-annual report to Congress of the U.S. Atomic Energy Commission (A.E.C.) stresses the fact that the proposal made by President Eisenhower before the United Nations on December 8th last may bring about important new developments in the field of atomic energy on an international plane. This and other events throughout the world during the past year have drawn attention to the need for certain amendments to the American Atomic Energy Act. In this respect, various recommendations have now been prepared by the Commissioners and will be submitted to Congress shortly for consideration. The A.E.C. is continuing to expand its domestic raw materials procurement programme and has extended to March 31, 1962, the expiry date of its guaranteed minimum price schedule for uranium ores on the Colorado Plateau. The Commission also extended to February 28, 1957, the time during which initial production of uranium ore from new domestic mines will be eligible for bonus payments. These actions were taken to provide a continuing incentive for the discovery, development and production of uranium from domestic sources.

Ore is now being produced from over 525 American mines, mostly on the Colorado Plateau, the principal production coming from the Morrison and Shinarump formations, and, more recently, from the Chinle, Entrada and Todilto formations. In South Dakota and Wyoming the Lakota formation has been the principal source of ore production. Some production is also coming from fissure veins in the Marysvale, Utah, district, the Colorado Front Range, and the Boulder Batholith area near Boulder, Montana. The three main kinds of ore being produced are the vanadium-rich ores from the Morrison formation, the vanadium-poor ores from the Shinarump formation and the limestone ores from the Todilto formation. Mine operators, who a few years ago were mining ore mostly from the rims of canyons or through inclined shafts a short distance back from the rims, are now mining through vertical shafts up to 600ft deep, as the more easily accessible deposits are depleted and deeper deposits are discovered and developed. The completion of the new ore-processing plant at Bluewater, near Grants, New Mexico, by the Anaconda Copper Mining Company increased to nine the number of uranium ore-processing plants in the United States. A second plant for the by-product recovery of uranium from phosphate rock was completed at Texas City, Texas, by the Texas City Chemicals, Incorporated, and is now in production. The U.S. Bureau of Public Roads has allocated a million dollars for the construction of 131 additional miles of access roads into uranium producing areas. These roads are being built in Utah, Colorado, Arizona, New Mexico, and South Dakota. A total of 783 miles of access roads was completed under an earlier programme.

The principal area of exploration activity by the Commission continues to be the Colorado Plateau, where most of the domestic uranium ore is produced. On the Colorado Plateau private interests have discovered substantial new ore deposits in the vicinity of Big Indian Wash, near Moab, Utah, in the Chinle formation, a hitherto relatively unproductive source. Drilling and other exploration work by the Commission and by private operators have revealed additional ore deposits in this area. An important aspect of the raw materials programme of the A.E.C. is research and process development. Process technology studies have been undertaken to find means of treating new kinds of ore, both foreign and domestic, and to develop suitable methods of extracting uranium as a by-product from such low-grade sources as phosphate rock, shale and lignite. Commercial phosphate rock, a source of by-product uranium, is now being produced from the lower layer of the Bone Valley formation in Florida. The upper layer of the Bone Valley is known locally as the leached zone. This material is being discarded as overburden waste during mining operations. The leached zone contains uranium in concentrations somewhat higher than in the phosphate rock and because the zone is extensive it is an important potential source of uranium. The A.E.C. has been investigating the feasibility of extracting uranium and possible co-products such as phosphate and alumina from the material.

Production

The quantity of fissionable materials produced during the last half of 1953 met the approved schedules, with the trend of production continuing to rise. All plants of the originally planned Feed Materials Production centre at Fernald, Ohio, have been completed and are being successfully operated. Some of the units of this integrated centre are now being expanded. The first significant use of heat from a production reactor will be made in the new reactor area now under construction at Hanford, Washington. Buildings in the area will be heated by water circulating through ordinary heating equipment after prior heating in a heat exchanger through which reactor effluent water will be pumped. The excessive radio-activity in the effluent water prevents its direct use in equipment for the heating of buildings. The heating system will save an estimated 1,500,000 U.S. gallons of fuel oil annually, and the initial investment of 614,000 dollars—based on the cost of equipment required to use reactor heat compared with the cost of conventional heating facilities—will be amortised in less than eight years through fuel savings.

A substantial portion of the power currently required by the Paducah diffusion plant is being supplied by three turbo-generators of the T.V.A. Shawnee steam power station and by two turbo-generators of the Joppa steam power station of Electric Energy, Incorporated. To meet the power requirements of the eventual full-scale operation of the Paducah and Oak Ridge gaseous diffusion plants fifteen additional turbo-generators are now being designed and constructed. Four of these units are to be installed at the Joppa station, and T.V.A. will install the eleven others at various stations in its system.

By November of last year, largely as a result of progress in the construction of the major new plants at Savannah River, Paducah, Oak Ridge, Portsmouth and Hanford, the American capital investment in atomic energy plant facilities was estimated to have grown to about 5000 million dollars. The costs incurred for new plant and equipment averaged about 100 million dollars a month during the second half of 1953, compared with an average of 97,000,000 dollars a month in the first half. After rising to an estimated monthly peak of 125 million dollars early in 1954, the monthly construction costs are expected to decline gradually, bringing the average level of such costs to about 115 million dollars per month for the first six months of 1954. At their peak monthly level the construction costs borne by the A.E.C. will be about 5 per cent of the estimated total monthly construction expenditure in the United States.

Reactor Development

The Commission is continuing its programme of developing improved reactors for industrial nuclear power generation and naval and aircraft propulsion. In addition, the A.E.C. sponsored research and development aims specifically at improving the production reactors at Hanford and Savannah River. Both military propulsion and the production reactor activities contribute indirectly to development of industrial nuclear power. During the past six months, a project was started for the first full-scale industrial nuclear power plant and the programme of industrial participation in nuclear power studies was enlarged. The present estimates of the cost of nuclear power plants vary greatly and exceed by a wide margin the cost of 150 dollars to 250 dollars per kilowatt of installed capacity of conventional power stations. Recent studies indicate that even after low-cost nuclear fuel becomes available not more than about 300 dollars per kilowatt of installed capacity can be spent if a nuclear power plant is to be competitive. Higher construction costs would have to be offset by returns from the sale of by-products. The reactor development activities of the A.E.C., supplemented by the continuing surveys of industrial groups, have indicated four major technical approaches to industrial nuclear power generation at a cost which may eventually be comparable with the cost of power from coal, oil or gas. These are the pressurised water, the sodium graphite, the fast breeder and the homogeneous reactors.

In July, 1953, the Commission authorised a new nuclear power project, known as the Pressurised Water Reactor (P.W.R.), and the development, design and construction of the reactor part of the plant was assigned to the Westinghouse Electric Corporation. With an electrical capacity of at least 60MW, it is felt that the P.W.R. will be a major advance toward the realisation of civilian nuclear power. Building and operating a plant of this size will yield much more dependable cost data and technological experience than could be obtained from a smaller plant. The pressurised light water reactor was selected in part because more is known about this design than about other ones. A number of early American reactors were water cooled, and this technology was advanced considerably more by the recent work of Westinghouse on the Submarine Thermal Reactor and on the cancelled large ship reactor project at Bettis Field. Only a slight enrichment of the uranium fuel will be necessary to achieve a critical mass with the light water moderator and coolant used in this reactor. Research and development on the P.W.R. is proceeding, and nuclear experiments are being conducted to determine the amount of uranium fuel needed, its exact enrichment, the shape of the fuel elements and methods of fabricating them. According to preliminary scheduling, this power plant should be in operation within three or four years. The possibility of siting it at or near one of the A.E.C. production plants to supply a small part of the power required by the plant is being considered.

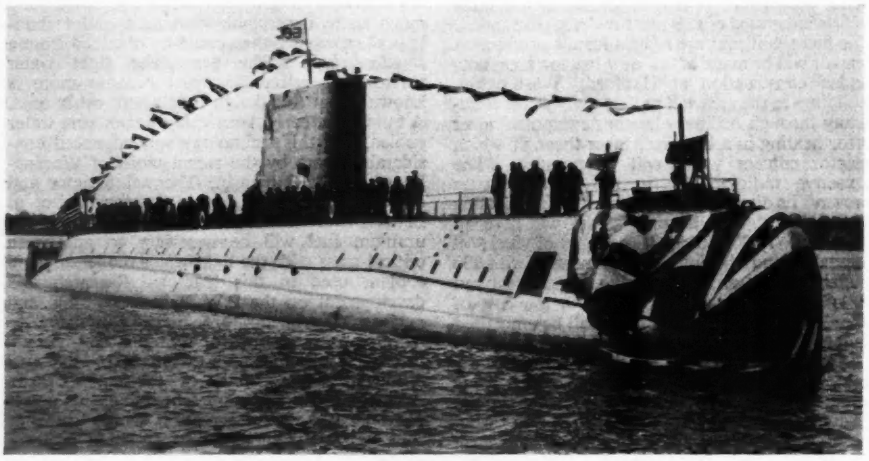
North American Aviation, Incorporated, the major contractor exploring sodium-graphite power reactors, has continued its investigations on a reactor which would be cooled by liquid sodium, moderated by graphite and would require slightly enriched uranium fuel. This design is largely based on graphite technology developed at Hanford and sodium technology which has grown out of work on the Submarine Intermediate Reactor by the Knolls Atomic Power Laboratory and the Oak Ridge National Laboratory.

The Argonne National Laboratory continued its promising, yet very difficult research and development work toward a practical breeder reactor for power generating purposes—a reactor that would produce as much or more fissionable material as it consumes. A fast reactor in which fuel is fissioned largely by fast neutrons now appears to be most attractive for this purpose. More detailed data on the breeding process was obtained by Argonne from various investigations, including those with the Experimental Breeder Reactor at the National Reactor Testing Station in Idaho. The Homogeneous Reactor Experiment, an experimental reactor with a 1000kW heat output, and its nuclear power plant at Oak Ridge were put back into operation after being shut down several months for improvements. A variety of experiments continued to produce much data on the unique homogeneous design in which the fuel and moderator are one liquid. Its potential advantages include the simple chemical processing of fuel, the simplicity of construction, and the elimination of fuel fabrication.

The experimental operation of the prototype Submarine Thermal Reactor at the National Reactor Testing Station was continued by the Westinghouse Electric Corporation as part of the programme of testing the reactor and its associated equipment. The results obtained made it

possible to improve the actual S.T.R. power plant being fabricated by Westinghouse for the first American atomic-powered submarine, which has been christened the U.S.S. " Nautilus." It is shown in the accompanying illustration after launching by the Electric Boat Division of the General Dynamics Corporation at Groton, Connecticut, on January 21st. The keel for the second nuclear submarine, the U.S.S. " Sea Wolf," was laid on September 15th at the same yard. The " Sea Wolf " will be powered by the Submarine Intermediate Reactor (S.I.R.) nuclear power plant which, together with propulsion machinery, is being built by the American General Electric Company. The Knolls Atomic Power Laboratory is continuing the development of an advanced nuclear power plant which would give a submarine higher speed than the S.T.R. and S.I.R. power plants and would show other improved characteristics.

Besides the Commission's work on specific reactor projects, a broad programme of research and development has continued. The object of the programme is to acquire general information for furthering the promising reactor designs



U.S.S. " Nautilus " after Launching

and for developing new ones. These investigations include a number of aspects of reactor development ranging from physics and design evaluation studies to recovery of valuable fuel from radio-active wastes, safe release of the wastes, and possible uses for reactor fission products. The Materials Testing Reactor (M.T.R.) at the National Reactor Testing Station is an important tool used in these investigations. During its first year of irradiation working, 128 irradiation projects, submitted by thirty contractors, were approved. The projects vary as to the number of specimens involved, the duration of the irradiation, and the complexity of the associated equipment. Most irradiations merely call for samples of materials to be inserted in the reactor. A few are very elaborate, requiring circulation of a coolant around the specimen and maintenance of certain temperatures and pressures with the necessary instrumentation, controls and safeguards. The recent addition of hydraulic " rabbit " facilities makes it possible to enclose small samples in capsules and run them into and out of the high flux regions of the reactor without having to shut it down each time.

A building housing a " hot cave " has now been completed. With this facility it is possible to examine and work on highly radio-active samples which hitherto could be inspected only under many feet of water in the fuel element discharge canal. A crystal spectrometer was placed in operation at the M.T.R. Since the spectrometer utilises the especially high neutron flux of the reactor it can make nuclear measurements of various materials that cannot be made elsewhere. Two other new research tools at this site are a " neutron chopper " which sorts neutrons by energy ranges and a neutron flux calibrator, which makes the determination of absolute flux values a practical proposition.

At the National Reactor Testing Station improvements have been made in the operation of the new experimental chemical plant which went into service early in 1953, recovering uranium 235 from partly burned enriched reactor fuel. After successfully handling moderately radioactive fuel the plant began operation with highly radioactive materials early in the autumn. The part of the plant in which waste gases are decontaminated of their radio-activity prior to discharge into the atmosphere has been tested and put into preliminary operation.

At the University of Texas experiments seeking better and cheaper methods of concentrating low-level wastes from nuclear reactors have shown that the radioactivity of such wastes in liquid form can be transferred to algæ and the algæ removed by rotary vacuum filters. Thus the volume of radioactive liquid which must be retained can be reduced many times. An essentially complete removal of the algæ has been demonstrated, and the efficiency of this method is comparable to that of the trickling filter sewage treatment process. A slightly modified trickling filter process went into operation at the National Reactor Testing Station. The plant is the first to combine the treatment of domestic and radio-active laundry wastes and has been found cheaper to operate than two separate treatment plants.

Physical Research

The physical sciences continue to play an important part in the development of atomic energy. There is a constant need for the generation of new information, and the Commission tries to meet this need through research contracts with universities and private institutions and through the research programmes of the national laboratories. The activities of the Neutron Cross Sections Advisory Group of the A.E.C. have been expanded to include cross-sections of all kinds (neutron, proton, deuteron, heavy nuclei, photons, electrons, &c.) and of all energies of interest to the Commission. The name of the group has been changed to the Nuclear Cross Sections Advisory Group to reflect this change in scope. Accurate measurements with the " slow chopper " have been completed at the Brookhaven reactor on the neutron cross-section of normal boron and gold. Very low energy neutrons and thermal neutrons were used in this work. Recent measurements with the " slow chopper " are believed accurate to ½ per cent and differ from the formerly accepted measurements by about 4 per cent. The normal boron and gold cross sections are used as standards for other cross-section measurements which are needed for reactor design.

The " fast chopper " has been operating at the Brookhaven reactor twenty-four hours a day, seven days a week, measuring total neutron cross-sections. The results obtained with this " chopper " show that a much better energy resolution is obtained than was available with previous instruments. Higher resolution will be available when the rotor is run at higher speed and improved scintillation detectors are being used for neutron detection. In addition to investigations on classified materials useful for reactor and weapon work, other elements have been investigated which are significant in testing theoretical models for the nucleus. The neutron cross-section compilation group at the Brookhaven National Laboratory is continuing to collect, compile and evaluate neutron cross-section data in the energy range of 0·0001 eV to 100 MeV.

A betatron neutron time-of-flight project at the Knolls Atomic Power Laboratory is making considerable progress in the determination of neutron cross sections. The precise timing with which the betatron electron beam can be made to strike its target is making possible a high rate of measurement of neutron absorption cross-sections and neutron resonance limits. The knowledge being developed is of fundamental importance in reactor physics and the precision of recent cross-section determinations using the new methods exceeds that hitherto possible.

One of the main developments in nuclear chemistry at Brookhaven has been the study of nuclear reactions in the hitherto unexplored high energy region. Early in 1953 radio-chemical investigations were begun on targets irradiated in the 2200 MeV proton beam of the cosmotron. The radio-active end products of the bombardment of target nuclei by particles isolated chemically are studied by means of the radiations they emit. This study of nuclear reactions is quite different from and complementary to the physical investigations by cloud chamber, counter or photographic emulsion techniques, in which the emitted particles, such as mesons, protons and neutrons, are detected and measured. The chief effect has been to learn whether the radioactive products resulting from the bombardment of some representative target elements with 2200 MeV protons differ markedly in kind and in relative yields from those observed with protons in the 200 to 400 MeV range, where many similar studies with synchro-cyclotrons have been made. The results indicate that the distribution of products from a given target element differs substantially in the two energy regions.

The Ames Laboratory at the Iowa State College and the Oak Ridge National Laboratory are conducting basic studies of the rare earths and the development of methods to separate them. Recently the Ames process for extracting pure earth elements from ore and separating them in ion-exchange columns was improved so that the yields increased considerably. Scientists at Ames have succeeded in separating, in 99·99 per cent purity, at least a kilogramme quantity of each of the rare earths which occur in Nature, except europium and terbium. They have, however, obtained smaller quantities of terbium. In addition, much progress has been made at Ames on the development of a liquid-liquid extraction process for separating rare earths in large quantities, starting directly with the ore. A loan collection of these pure rare earths was established at the Ames Laboratory, and a number of scientists received loans of various amounts of pure rare earths for use in their research work. At Oak Ridge a process has been developed which will make most of the rare earths available in small quantities in pure form at greatly reduced cost ; it consists of counter-current extraction of nitric acid solutions of the rare earths with tributyl phosphate in a system of glass columns. Kilogramme quantities of the oxides of samarium, gadolinium and dysprosium have already been separated from complex mixtures. Progress is continuing in the improvement of the process and its extension to some of the other rare earths.

When a crystalline material is placed in a beam of neutrons, the scattering of neutrons out of the beam can give information about the arrangement of atoms within the crystal. This mode of experiment, which is of special use when applied to crystals containing hydrogen is being applied at Oak Ridge to furnish fundamental chemical information. For example, a neutron diffraction study of ice disclosed the precise separation of the two hydrogen atoms and the oxygen atom which comprise a molecule

of water. The study also yielded information about the motion of these atoms and about the manner in which adjacent molecules are arranged. Studies in the field of radiation damage have shown that changes in the physical properties of irradiated metal are caused by the introduction of defects into the normal crystal structure of the metal. These defects are formed by the bombarding neutrons which knock atoms from their normal positions. The defects are : (1) vacant spots in the crystal structures, called vacancies ; (2) displaced atoms in an abnormal position, called interstitial atoms ; (3) impurity atoms resulting from reaction of neutrons with the original atoms to form a new atom ; (4) local high-temperature regions introduced by the slowing down of the original high-speed neutron. The Oak Ridge National Laboratory has demonstrated that the vacancies introduced into the crystal structure by neutron bombardment can greatly increase the rate of intermingling of different atoms in an alloy. Evidence also has been found that interstitial atoms cause an increase in hardness and strength.

Many nuclei spin about their axes and behave like tiny magnets. The strength of these magnets is so small that the direction in which the nuclei point is random and continually changing under the influence of ordinary heat motion. It has long been a goal of nuclear physicists to rearrange nuclei so that they point predominantly in one direction and then to make them interact with sub-nuclear particles, such as neutrons, which have also been aligned. The object of such rearrangement is to determine if the interaction is in any way influenced by the orientation of the nuclei and the particles. Physicists at Oak Ridge working at 0·2 deg. Fah. above absolute zero (−459·72 deg. Fah.) have recently succeeded in observing effects of this kind. An external magnetic field was applied to manganese ammonium sulphate and to samarium ethyl sulphate so that the tiny nuclear magnets were aligned. When polarised neutrons were shot into the manganese sample, the manganese captured 3·4 per cent more neutrons when the nuclear magnets and the neutrons were aligned anti-parallel than when they were aligned parallel. In the case of samarium the effect was similar, but the neutron capture was 18 per cent greater.

Research Tools

The tools being used for physical research in the field of atomic energy are constantly being improved and new instruments are being developed to obtain more precise and accurate information. Many of the instruments that are developed for use in fundamental research have multiple applications, some of which make possible the solution of problems of immediate importance to the atomic energy programme. The Brookhaven reactor, which is the only nuclear pile in the United States designed for research programmes in both the physical and life sciences, has now been operating continuously for over three years. It was brought into operation in August, 1950, and has exceeded original performance characteristics in all respects. Designed to operate at 27MW, it has achieved levels as high as 30MW on an around-the-clock schedule. Some forty separate research equipment arrays set up at the various faces of the reactor pursue simultaneous investigations. In many of these projects the results are automatically recorded twenty-four hours each day.

The thermal test reactor at the Knolls Atomic Power Laboratory, which was originally designed as a versatile research tool for precise reactivity measurements and as a standard neutron source, has been used extensively for cross-section measurements, the testing of materials used in reactor construction and for neutron calibrations. To meet the need for high neutron flux levels, the reactor has been modified to include water cooling for operation at 10kW. This power provides neutron fluxes greater than 100,000 million neutrons per square centimetre per second, which can be used for the production of experimental quantities of radio-active isotopes and for neutron beam experiments.

The Raleigh research reactor, which is the first nuclear pile in America to be owned by a university, went critical on September 5, 1953, at the North Carolina State College of the Consolidated University of North Carolina. This low-powered research reactor was completely designed and built with funds of the Consolidated University. The A.E.C. has loaned 999 grammes of uranium 235 to fuel the reactor. One of the major purposes of the reactor will be to supply operating experience to under-graduate and post-graduate students in nuclear engineering. For the first year of its operation a programme of research on the reactor itself is scheduled, after which the emphasis will shift to the use of radiations and radio-active isotopes produced by the reactor.

A small " water boiler " research reactor was put into use by the California Research and Development Company, at the Livermore research facility of the A.E.C. in California. It is generally similar to other " water boilers " ; it has a sperical, stainless steel core 12in in diameter and uses about 1kg of uranium 235 in a uranyl sulphate solution of ordinary water. The power is 100W and the maximum flux of thermal neutrons is 1,000 million per square centimetre per second.

The Argonne computer, the AVIDAC, which was designed to simplify the mathematical problems associated with reactors, and another computer, called the ORACLE, have been completed recently. The ORACLE was moved in September from Argonne to Oak Ridge and is now in use by the mathematics panel of the Oak Ridge National Laboratory. Both machines are based on the general design of one begun earlier at the Institute for Advanced Study at Princeton. Each computer contains about 3500 electronic valves and about 20,000 resistors. These machines can multiply together two twelve-digit numbers in less than 1/2000 second. The ORACLE was designed after much of the work on the AVIDAC was completed, and it contains many improvements, for example, the memory device. In both machines instructions and intermediate results of computation are held in a memory unit consisting of cathode ray tubes and auxiliary circuits. In the ORACLE pairs of cathode ray tubes are used so that the second tube will remember what the first one is unable to, because of small defects in the first tube. Either one tube or the other gives the right answer. Using this system, the machine has been found to have a very high degree of reliability.

Since June, 1953, the cosmotron at Brookhaven, with only occasional interruptions, has been providing high-energy particles for experiments on a schedule calling for sixty hours of operating time a week. In normal operation protons are accelerated to energies as high as 2200 MeV, but in test runs energies as high as 2800 MeV have been reached without difficulty. Regular operation at an energy level of 3000 MeV is to start this year. The construction of an ultra-high-energy particle accelerator of a design known as an alternating-gradient proton synchrotron has now been authorised and the Brookhaven National Laboratory has begun the design of a machine that will accelerate protons to energies up to 25,000 MeV. This synchrotron will use a series of alternate strongly converging and diverging magnetic fields to confine a proton beam in a tube of relatively small cross-section. This focusing effect will allow the production of high-energy beams with smaller electromagnets and related equipment than would otherwise be possible.

By accelerating large current protons to an energy of 22 MeV, the 86in cyclotron at the Oak Ridge National Laboratory is capable of producing special radioactive isotopes at rates many times higher than any previously reported. For example, beryllium 7, an important research isotope, is produced at the rate of 100 millicuries per hour by bombarding lithium with protons. Comparable high yields of other isotopes have been obtained, and the high production rate has materially reduced the costs of these isotopes. The cyclotron is now being modified to produce high-energy neutrons.

A recently developed instrument of major importance for the detection and measurement of nuclear radiations is the scintillation counter. This device is the modern development of a very old method of counting radioactive rays. In its original form the human eye observed and counted the light flashes produced in a fluorescent screen which was irradiated with alpha particles from a radioactive substance. In the modern instrument the human eye is replaced by a more sensitive device, the photo-multiplier. This device can detect very small scintillations, count them as rapidly as 1,000,000 per second, and at the same time discriminate accurately between light flashes of different brightness. By replacing the micro-crystalline fluorescent screen with large single crystals the scintillation counter can count, not only alpha particles, but beta particles, gamma rays and, with special crystals, neutrons. Until recently the use of scintillation counters was limited because of the difficulty of obtaining single crystals of sufficient size to obtain the desired sensitivity. After intensive study the Argonne National Laboratory has succeeded in developing several scintillating plastics which compare well in performance to the best crystals. The Argonne research programme on scintillation materials has produced a great deal of information about the nature of the scintillation process by which part of the energy of the radioactive particle is converted into visible or ultra-violet light. An apparatus has been devised for measuring the intensity, spectral distribution and time duration or " lifetime " of the scintillations, and is capable of measuring time intervals as short as 5/1,000,000,000 second with an accuracy of about 4 per cent.

In certain mass spectrographs used in atomic energy research work, the atoms are charged electrically, accelerated to high velocities by electric fields and then sorted out by deflecting magnetic fields. Particles of different masses are deflected through different angles and thus separated. One method of producing charged particles is to put a tiny speck of the material to be studied on a strip of metal which is then heated electrically to vaporise the material. A fraction of the atoms evaporated are then electrically charged by the capture of electrons released by the hot metal strip. Using a variation of this method, the Argonne National Laboratory has recently been able to increase the sensitivity of its mass spectrograph making it possible to analyse smaller samples than those previously studied. Developments in mass spectrometry at the Knolls Atomic Power Laboratory have achieved high sensitivity in the detection of ion beams for the investigation of isotopic changes in materials exposed in reactors, and the construction of a dual-magnet mass spectrometer for the measurement of isotopic concentrations is now in progress. A non-magnetic mass spectrometer of high transmission has been developed at the University of California Radiation Laboratory to aid in the mass assignment of cyclotron-produced radioactive nuclides and in the study of their radiation without interference from other isotopes. The spectrometer is a time-of-flight device based on a novel use of high-frequency sawtooth voltages applied to a grid system. Ions formed in the source end pass through a long cylindrical evacuated tube. Mass selection is based on the time-of-flight through the main part of the tube, the only ions recovered at the receiver end being those which reach the receiver end grids at the proper time for acceleration by the sawtooth grid voltage.

Book of Reference

World Road Statistics, 1953 (*Revised Edition*). London : The International Road Federation, Ltd., 18, South Street, W.1. Price 12s. 6d.—Statistics about road conditions in some seventy-five countries are to be found in this publication, including such items as the diversity of vehicle taxation methods, rate of fuel tax and density of traffic. The tabulated information includes revenues from fuel and vehicle taxes, which are compared with expenditures on roads in various countries. One table, in addition to stating the total length of roads in each country, classifies them into three categories—" Hard Surface," " Improved " and " Unimproved." The allocation of road expenditures is also shown by a percentage system as between the various authorities. Other figures relate to the length of roads by comparison with areas and populations, while the numbers of vehicles of various kinds are similarly compared. This new edition is printed in French as well as English.

Marine Shafting Alignment

"MARINE SHAFTING ALIGNMENT" was the title of the paper given on March 12th before the North East Coast Institution of Engineers and Shipbuilders. The paper, which we summarise, was presented in two parts: Part I, "Practical Methods Employed in the Alignment of Marine Shafting," was read by Mr. G. Yellowley, and Part 2, entitled "Influence of Stern Bush Wear-down on Loading of Propeller Shaft Bearings," was presented by J. E. Richards, B.Sc. (Eng.), Ph.D., Wh.Sc.

In Part I of the paper the criterion of shafting alignment is stated and it is suggested that experience gained in using a new technique for checking alignment indicates the need to review existing criteria. The general procedure during installation is reviewed from the initial alignment of the stern frame boss to the fitting of the engine and then one or two instances are described which showed the importance of the alignment of crankshaft journals and the need to modify existing procedure. The use of a stretched piano wire for checking long machined beds and the disadvantages of the method are recalled while the accuracy of the Taylor Hobson alignment telescope is noted and the disadvantage that it cannot be located near the crankshaft centre line. Efforts to overcome the difficulties by improving the existing sighting equipment and testing the accuracy of the occultation of a beam of light are described.

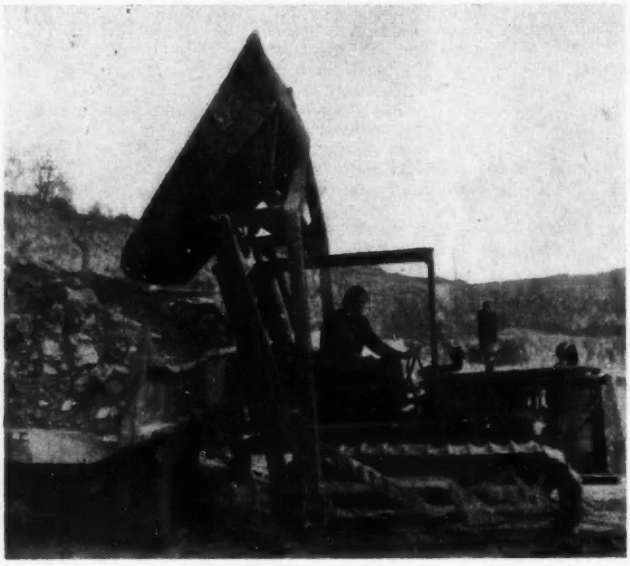
After proving the method its application is considered and the paper goes on to give a description of a crankshaft and bedplate sighting alignment gear together with a tabular statement showing its accuracy compared with telescope alignment. The various stages in the setting of a main engine bedplate in a ship are recounted and the results are given of checks made with the equipment upon the alignment of an engine during construction. This is followed by reports upon investigations made upon alignment on a number of vessels in service and the results are recorded graphically. As a result of practical tests it is concluded in the paper that the sighting method is considered to be generally more reliable than dependence upon deflections of the crankweb and the main bearing wear-down. To eliminate athwartship twist the use of levels is recommended and it is stated that more information is required about the deflection of engine seatings and bedplate in motor-driven vessels of high power, while consideration is recommended to be given to the "step effect" at the change of section at engine seating and bedplate.

In the second part of the paper it is pointed out that it may be desirable to reduce bending stresses in shafting by a redisposition of bearings and that there is a simpler approach to calculating bearing loads than the theorem of three moments. It is suggested that the bearing loads should be worked out for a definite shafting arrangement and the effect of alterations investigated. The British Shipbuilding Research Association, it is stated, has carried out such calculations for a 17,000-ton deadweight oil tanker for three stated conditions which involved the movement of the first plummer block to new positions. To find out the effect of the stiffness of the shafting upon the results it is mentioned that the calculations were repeated for a smaller diameter of shaft and that since the degree of fixity at the engine coupling was unknown some assumptions, which are listed, had to be made. The results of the calculations are shown graphically, the wear-down of the stern bush being plotted against the load in pounds for loads on stern bush, first, second and third plummer blocks.

Note is taken of the additional forces arising from the motion of the propeller, and the only force affecting the investigation is stated to be composed of the force due to varying torque and the moment due to the varying thrust on each blade as it passes through the non-uniform wake. In the paper consideration is given to the effect of constant components of the hydrodynamic forces on the loading of the plummer blocks and it is stated that the effect will vary with the wear-down of the stern bush. With regard to the effect of blade frequency and higher components of the hydro-dynamic forces it is noted that the shape of the after body of the ship affects the magnitude of these components. Turning to the allowable wear-down of the stern bush certain conclusions are mentioned and the paper concludes with some remarks upon practical considerations such as the provision of the means of adjusting the height of the after plummer block, together with the adoption of the minimum clearance.

Tractor-Operated Loader

WE have received some particulars of a new loader which is being produced by Anthony Hoists, Ltd., for use exclusively with the "BTD–6" and "BT–6" crawler tractors made by International Harvester Company of Great Britain, Ltd., 259, City Road, London, E.C.1. As the accompanying illustration shows, the loader consists principally of a combined bucket and chute assembled on a steel A-frame which is mounted at the rear pivot points of the tractor.



Tractor with Hydraulically-Operated Bucket in the Discharging Position

The bucket is loaded by moving the tractor forward, after which it is raised by hydraulic rams, over the head of the driver, while the tractor is being reversed to the unloading point. At the end of this reversing movement, the bucket is automatically tripped and its load is discharged at the rear of the tractor. If necessary, however, the loaded bucket can be held overhead while the tractor is travelling to the unloading point. The bucket is returned by the hydraulic system to its loading position as the tractor moves forward again. The capacity of the bucket is ¾ cubic yard and its overall width is 5ft 6½in. Its width thus exceeds the width of the tractor, so that, if required, the equipment can make its own "road" through the pile of material to be shifted. It is stated by the makers that the main use of the loader is for shifting loose material which is piled, stacked or blasted free above ground level, though it can, it is claimed, dig effectively to 10in below ground level. An angledozer blade is available as an attachment to the loader.

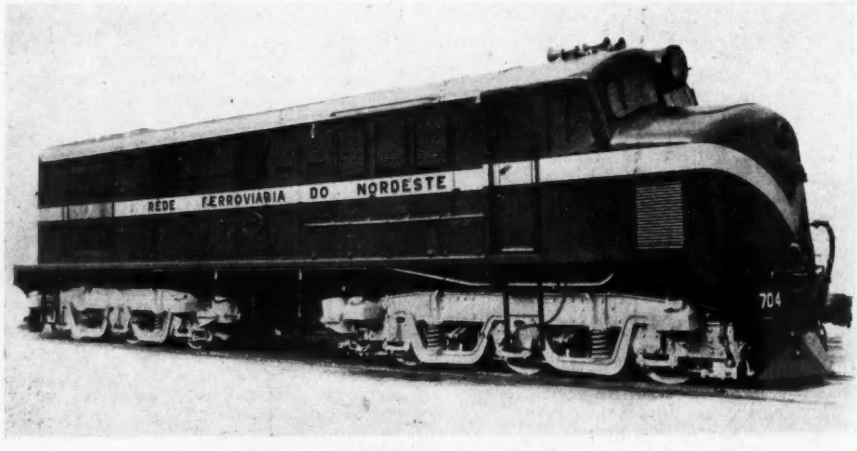
Diesel-Electric Locomotives for Brazil

THIRTEEN 1000 h.p. diesel-electric locomotives are being built by the English Electric Company, Ltd., for passenger and freight service on the metre gauge system of the Rede Ferroviara do Nordeste, formerly the Great Western of Brazil Railway. The diesel-electric power equipments for these locomotives are being built by the English Electric Company and the mechanical parts by the Vulcan Foundry, Ltd. These locomotives are of the "A1A–A1A" type, having two three-axle bogies, the outer axles of which are motored.

The new locomotives are to be placed in service on the Central line from Recife to Afogadas de Ingazeira, a distance of 250 miles, and on the Southern line to Maceio, a distance of 216 miles, and are designed to make a return trip over either of these two lines without refuelling.

One of the new locomotives is illustrated below and its leading particulars are tabulated on page 583.

The underframe of the locomotive is of welded construction and the truss design main longitudinal members, which extend the full length, are deepened towards the centre to form the sides of the fuel tank. The main members are braced with cross stretchers and gussets and fabricated dragboxes at either end of the underframe accommodate the automatic coupler drawgear. The superstructure is fabricated as a unit, and is welded to the underframe. This superstructure has five compartments which are separated by bulkheads. Behind the nose compartment there is a full width driving cab in which there is



1000 H.P. Diesel-Electric Locomotive for Brazil

a driving position for either direction of travel.

Each of the three-axle swing bolster bogies has a fabricated frame, carried on four nests of coil springs which rest on equalising beams supported on the roller bearing axleboxes. The position of the coil springs is arranged so that the static axle loads are equalised.

The load from the locomotive superstructure is transferred to the bogie frame through a fabricated bolster to four laminated spring groups. Two of these spring groups rest on each spring plank which is suspended from the bogie transoms by inclined swing links. Lateral movement of the bolster is limited by stops and manganese faces are provided on the bolster and transoms which transmit the tractive forces. Laminated bolster springs are proportioned to work in conjunction with the coil springs mounted on the equalising beams.

Main Particulars of 1000 *h.p. Diesel Electric Locomotive*

Weight in working order	71 tons
Maximum axle load	12 tons
Length over couplers	50ft 3½in
Overall width	8ft 10in
Height from rail to roof	12ft 3in
Total wheelbase	39ft
Bogie wheelbase	12ft
Wheel diameter	3ft 1in
Fuel tank capacity	540 gallons
Gear ratio	61/15
Starting tractive effort (25 per cent adhesion)	27,000 lb
Continuous tractive effort at 12 m.p.h.	20,400 lb
Maximum speed	60 m.p.h.

The English Electric " 8SRKT " diesel engine, with main and auxiliary generators, form a single unit which is supported at three points on resilient mountings. This eight-cylinder, four-stroke, supercharged engine is rated continuously at 1000 b.h.p. at 850 r.p.m., but to meet the conditions of high temperature and humidity prevalent in Brazil it is derated to 874 b.h.p. at 850 r.p.m. The engine governor, which is driven from the camshaft at the flywheel end of the engine, regulates the quantity of fuel delivered by the fuel injection pumps by means of a servo mechanism operated from the lubricating system. The engine is started by motoring the main generator from a forty-eight-cell, 123Ah (five-hour rate), lead-acid battery, housed in two containers mounted on each side of the locomotive running plate.

A six-pole d.c. main generator supplies current to the four traction motors; it is a self-ventilated, single-bearing machine. The generator frame is bolted to the flywheel housing of the diesel engine, and at the non-driving end is machined to receive an end-shield to which the frame of the overhung auxiliary generator is bolted. A shunt-wound auxiliary generator, controlled by an automatic voltage regulator, supplies current at 110V for the excitation of the main generator, control circuits, blower and exhauster motors, locomotive lighting and battery charging.

Two series-wound, six-pole force-ventilated traction motors are mounted on the outer axles of each bogie. Two stages of automatic field weakening are provided by diverter resistances to enable constant wheel tread horsepower to be obtained throughout the required speed range. The traction motors are permanently connected in two parallel groups of two motors in series.

At each driving position a master switch, control handle and brake valve are provided, together with an instrument panel and indicator lights. The engine is started with the master switch in the " engine only " position, and then the switch is moved to select the appropriate direction of motion. Initial movement of the control handle causes the reverser to be thrown to the pre-selected position and the motor contactors to close, connecting the traction motors to the main generator. At the same time, a small current is fed to the main generator field, thereby providing sufficient tractive effort to manœuvre the locomotive at the very low speeds required during coupling up. Further movement of the control handle causes fuel injection to be gradually increased, though the diesel engine continues to run at the minimum speed. Still further movement of the control handle progressively increases the engine speed up to the maximum.

After the initial movement of the control handle, the excitation of the main generator field is automatically controlled to ensure that the generator output at all times matches the available engine horsepower, irrespective of the engine speed or locomotive speed. Field weakening of the traction motors obtains automatically as a function of the regulator controlling the generator field excitation and is independent of diesel engine speed. Up to three locomotives may be coupled together and driven in multiple from one cab.

Long Centrifugal Castings

PARTICULARS have been received from Sheepbridge Engineering, Ltd., of Chesterfield, of a centrifugal process for making long single and dual metal castings—a process recently adopted by arrangement with the United States Pipe and Foundry Company, of America. The company points out that an associate firm, Sheepbridge Stokes, Ltd., has been manufacturing centrifugally cast cylinder liners for some thirty years. The methods used to produce these cylinder liners of relatively short lengths are, however, not well adapted for the production of long centrifugal castings, because permanent metal moulds are employed which cause the molten iron to solidify very rapidly, producing the characteristic fine structure of the cylinder liner centrifugal casting. In the past, different methods have been used in making cast iron pipe for carrying gas, water and other liquids, and

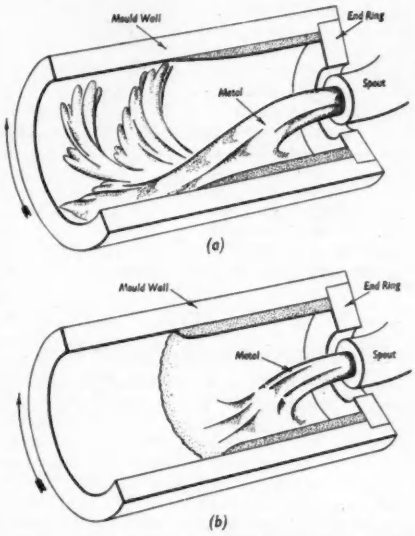


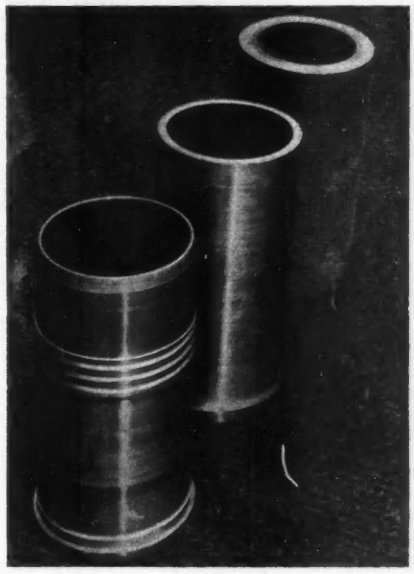
Diagram (a) Shows the Irregular Forward Movement of Metal on Either a Smoothly Coated or Bare Mould

Diagram (b) Shows the More Uniform Advance of the Metal Front on a Rough Sprayed Coating

the problem in casting long lengths is to make the molten metal run smoothly from one end of the casting to the other. The pipe makers use either a retractable inclined machine with a permanent metal mould, or a horizontal machine with a sand mould. The sand abstracts heat from the molten iron much less quickly than does a metal die, and the iron, therefore, stays fluid much longer and can run the full length of the casting.

The new casting technique developed by the United States Pipe and Foundry Company, of Burlington, New Jersey, permits the molten metal to flow in a controlled manner from one end of the casting to another, whilst still using a permanent metal mould with its obvious advantages. In this technique a sprayed coating of controllable characteristics is deposited on the surface of the metal die, and the thickness and the roughness of the coating can be adjusted as required. If a molten metal such as steel is poured into a rotating die, it normally tends to flow in an irregular manner and to solidify rapidly with many surface defects, but when poured on to a die coated in the new way, the metal flows smoothly and evenly over the whole length of the casting, as shown in the accompanying diagram (*b*).

The process is now in regular use at the works of Sheepbridge Engineering, Ltd., for the production of high-quality centrifugal castings for engineering purposes to much greater lengths than formerly. It is now able to cast much longer cylinder liners than hitherto and make long steel castings, both in mild and low alloy steels and in high alloy stainless and heat-resisting steels for the chemical, furnace and general engineering industries. A further advantage of the process is that it can be applied to the production of bimetal castings, in which one metal is cast against and welds with another



Large Diesel Engine Cylinder Liners Produced by the " Burlington " Process—as Cast, Rough Machined and Finished in Dual Metal with Iron Inside, Steel Outside

metal. It is now possible to produce long piping consisting of a mild steel exterior lined with a stainless steel interior, or, conversely, a mild steel pipe with an exterior surface of heat-resisting steel. The firm is at present producing castings up to a length of 10ft with maximum diameters of about 20in on steel and 30in on cast iron, but this range can be extended to meet demands as they arise. We are informed that castings produced by the new process will be available in a very wide range of compositions and they will have the qualities of centrifugal castings produced by the earlier processes in shorter lengths.

Gas-Turbine-Driven Fire Pump

BRIEF details have been released of a lightweight, high-speed centrifugal pump which has been developed by Sigmund Pumps, Ltd., Team Valley, Gateshead. It has been specifically designed to work in conjunction with the Rover 60 h.p. gas turbine and this portable turbine-driven fire pump shown on page 527 *ante* where there is a description of the gas turbine. This portable pack weighs 200 lb, the turbine itself weighing 112 lb.

The pump set incorporates a specially designed single stage centrifugal pump having a capacity of 400 g.p.m. at a total delivery head of 231ft when pumping from a 10ft static lift using three lengths of 4in smooth bore suction hose and a strainer. Discharge can be taken from two 2½in discharge pipes. The impeller rotates at 4500 r.p.m., this speed being obtained by reduction gearing incorporated partly in the pump and partly in the turbine.

The suction eye is provided with a standard 4in suction hose connection with removable internal strainer and blank cap, whilst on the delivery side two 2½in delivery valves of approved pattern with standard hose connection are provided.

Drive for the pump is taken from a pinion fitted on splines and supported in a double row conical roller bearing lubricated by pressurised oil from the turbine, this oil being injected into the bearings through a hollow shaft and

returned via the gear casing to the turbine oil sump. The bearing housing and gear chamber form part of the liquid space of the pump and are thus cooled by the liquid pumped. A plug is provided on the pump casing for the purpose of taking off cooling water if required. A mechanical seal is used for sealing of the stuffing-box, liquid collecting in the chamber between oil seal and mechanical seal being taken away through the drain hole.

The priming unit consists of an air ejector which takes the air for this purpose from the compressed air receiver of the gas turbine. This unit is operated by a single lever and is designed to lift water 24ft at the rate of not less than 1ft per second at atmospheric pressure.

Hand starting is by means of a cranked handle which folds down and is contained within the frame dimensions when not in use. The system incorporates a free-wheel which is completely enclosed and is automatically lubricated. The combined unit is mounted in a frame of tubular steel construction suitably braced. A fuel tank with sufficient capacity for twenty-five minutes' operation is secured within the frame by means of metal straps and an instrument panel positioned above the water pump is bolted to the tubular frame. Carrying handles which fold down when not in use are attached to the front and rear struts of the tubular frame. As an alternative the whole unit can be mounted on a trailer of welded construction incorporating twin angle towing bar and hand brake over-run mechanism, reversing catch, hose carriers and tool-box. The unit can be run on commercial petrol, commercial paraffin, diesel fuel or any distillate fuel.

Hydraulically-Operated Overloader

A NEW piece of loading equipment for bulk materials, developed by F. E. Weatherill, Ltd., Union Row, London, N.17, is the overhead loader, illustrated below. This machine, as can be seen, consists essentially of an industrial tractor fitted with hydraulically operated side arms carrying a scoop bucket of ¾ or 1 cubic yard capacity. The scoop is filled by driving it into the heap of material and raising it before backing the tractor in a straight line towards the loading point. The tractor is then stopped and the arms elevated to swing the scoop overhead and rearwards to deposit its load.

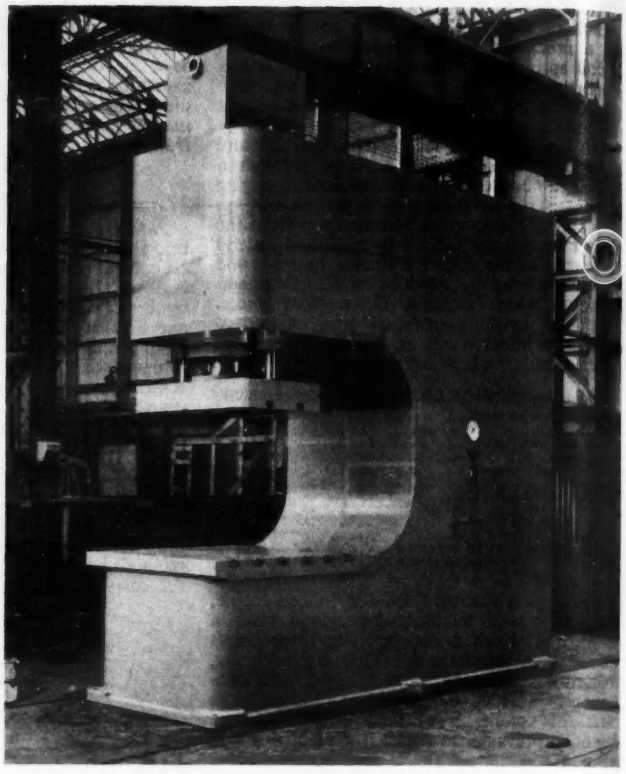
The makers say that up to four loading cycles a minute can be completed to handle about 100 tons of material an hour with the machine. Its operation does not involve so much manœuvring as with a normal loading shovel, with a consequent reduction in operator fatigue and mechanical wear and tear.

The side arms are raised for the first part of their travel by a pair of main rams located on each side of the frame towards the rear of the machine. At the limit of travel of those rams a set of secondary rams takes over and completes the overhead movement of the side arms and scoop. Crowding action of the scoop when pulling through the material is effected by two further hydraulic rams mounted on the side arms.

One movement of a single control lever is all that is necessary to complete the whole loading and discharge operation. This movement also applies a braking effect to automatically slow down the rate of movement of the side arms at the end of their travel just prior to the discharge of the load. This braking effect assists in the satisfactory emptying of the scoop. The same control lever brings the scoop back to the loading position under hydraulic power.

A further consideration is that the side arms do not travel past the operator and although the load itself must obviously pass overhead, the cab is specially reinforced to provide protection from involuntary spillage. The discharge height and reach is stated to be ample for loading high-sided trucks or wagons.

Hydraulica-llyOperated Overloader at Work



500-Ton Electric Hydraulic Press

500-Ton Electro-Hydraulic Press

HUGH SMITH AND CO. (POSSIL), Ltd., has recently completed the first of two 500-ton gap type shipyard flanging presses, which is illustrated herewith, for the Netherland Dock and Shipbuilding Company, Amsterdam. For the larger tankers now being constructed a press of considerable power is required and whereas formerly 250-ton gap type presses have had adequate power for average shipyard work, the present-day tendency is to use presses of 400 to 500 tons capacity. The gap from the centre line of the ram to the throat is 5ft, or 1500mm, and this large depth of gap demands a press frame of great rigidity to withstand the stresses involved; the welded steel frame of this press has a weight of 33 tons, while the finished press weighs 41 tons. In a frame of this size there is ample room to accommodate the electro-hydraulic pumping equipment, valves and piping without impairing accessibility, since access can be gained both from the rear of the press and from the top to simplify servicing. The "Electraulic" pump is driven by a 40 h.p. motor to give approach, pressing and return speeds of 3½in per second, 0·28in per second, and 3½in per second, respectively. The oil tank is situated directly above the cylinder with the prefilling valve contained within it, thus giving free flow of oil to and from the cylinder without any intermediate piping.

The main and return rams are of steel, chromium "Fescolised," and the high chromium finish, combined with the design of packings, ensures long periods between repacking. The pumps and valves are of Towler Brothers "Electraulic" manufacture, and the use of lapped-in "packingless" valves ensures freedom from the maintenance shut downs associated with the older types of hydraulic systems using leather packings. A similar press which is under construction for Alexander Stephen and Sons, Ltd., Glasgow, will be equipped with jib cranes mounted on the top of the press for the handling of plates and bars.

Technical Reports

A Review of Work Carried out at the National Physical Laboratory on the Creep and Corrosion Resistance of Steels for Steam Power Plant, 1930 to 1949 (Ref. J/T152). By A. M. Sage, B.Sc., A.I.M. The British Electrical and Allied Industries Research Association, Dorking Road, Leatherhead, Surrey. Price 18s., postage 4d.—This report briefly reviews the work of the E.R.A. from 1930–49, attention being drawn to the reasons for the various lines of investigation undertaken. The present position of work still in progress is also reviewed and mention is made of future work about to be started.

The Detection of Very Small Amounts of Iron in Electrolytic Copper (Ref. A/T130). By P. Armes, B.Sc. The British Electrical and Allied Industries Research Association, Dorking Road, Leatherhead, Surrey. Price 3s., postage 3d.—The accurate quantitative estimation of comparatively large amounts of iron in copper is described in B.S. 1800 : 1951; but this method is less suitable for the roughly quantitative detection of amounts below 50 parts per million. The method described in this report is similar in principle to the B.S. method, but is somewhat simpler and gives a more obvious response to the presence of iron in amounts around 5 parts per million. It is not intended to give accurate quantitative results.

The deep red coloration produced with ammonium thiocyanate solution provides a sensitive test for the presence of ferric iron. The sensitivity of the test is greatly reduced, however, in the presence of large amounts of copper, and is unsuitable for the detection of iron as an impurity in electrolytic copper unless copper is first removed from the solution. After copper has been removed in solution by filtration, the iron is retained as the hydroxide by adsorption on filter paper. The latter is then treated with ammonium thiocyanate to develop a visible coloration. This method is capable of detecting less than 0·01 mg Fe.

Industrial and Labour Notes

Engineering and Railway Wages

At a conference of the executives of the thirty-nine unions affiliated to the Confederation of Shipbuilding and Engineering Unions, which was held on Thursday of last week, it was decided to accept the wage increases offered by the employers' federations. These increases, which were reported in these notes last week, amount to 8s. 6d. a week for skilled men, 7s. 6d. for semi-skilled, and 6s. 6d. for unskilled men employed in the engineering and shipbuilding industries. They date from the week beginning April 5th. It has been stated that the proposal for acceptance was carried by a large majority. An amendment that the unions should approach the employers with a view to obtaining improved rates for unskilled workers was not carried.

On Wednesday of last week, there was a further meeting between the chairman of the British Transport Commission, Sir Brian Robertson, and representatives of the three railway unions for discussion of the proposed new railway wages structure. After the meeting it was stated that the Commission's proposals for a new wages structure had been presented to the union representatives. No details of these proposals have yet been made available.

Overseas Trade

Provisional figures prepared by the Board of Trade show the value of United Kingdom exports in March as £264,400,000. This represented a rate of export above that of the final quarter of last year and only about 2 per cent in value below the record first quarter of 1952. March was, however, a long working month of twenty-seven days. The March total has brought the monthly average value of exports in the first quarter of this year to £224,400,000, which was 3 per cent less than in the final quarter of last year, but 8 per cent higher than in the first quarter of 1953. Re-exports in March increased to a value of £11,600,000. The provisional value of imports in March has been put at £298,600,000, but the Board of Trade suggests that this is accounted for mainly by the longer working month. The total value of imports in the first quarter of this year was only a little above the total for the corresponding quarter of 1953. The excess of imports over total exports and re-exports averaged £40,300,000 a month in the first quarter of this year, which was about 9 per cent higher than the average for the fourth quarter of last year, but 25 per cent below the average for the first quarter of 1953.

These figures were mentioned by the President of the Board of Trade, Mr. Thorneycroft, during the debate on the Budget proposals on Monday last. He said that the absolute figure for exports was "not worth very much," as there could be a very high level of exports, but very little profit. Firms' order books, Mr. Thorneycroft continued, gave a delayed action effect on the export field, and in the first half of 1952 exports were still high, principally because there were still orders placed at the tail end of the current year and in the second half. Then events began to take effect, and orders fell away very steeply. What should be recognised, Mr. Thorneycroft said, was that 1953 was a year of recovery. It was not better than previous periods to the extent that could have been wished, but exports were going up during the course of 1953, and perhaps, on the whole, rather faster towards the end of that year. At the very end of last year, and in January and February of this year, Mr. Thorneycroft added, there could begin to be felt something of the effect of what in the U.S.A. was called "readjustment."

Employment and Unemployment

The latest report by the Ministry of Labour on the employment situation in Great Britain shows that during February the total working population decreased by about 30,000. At the end of that month it numbered 23,463,000 (15,930,000 men and 7,533,000 women), of which total 844,000 were serving in H.M. Forces.

The number in civil employment at the end of February was 22,273,000, a decline of 15,000 compared with the preceding month. In the basic industries 3,993,000 people were employed at the end of February, the principal changes in the month being an addition of 5000 to the number at work in agriculture, and an addition of 1000 to mining manpower. The number of wage earners on colliery books at the end of February was 709,000, compared with 717,000 a year earlier. In the manufacturing industries, the number of people employed at the end of February was 8,959,000, which indicated a net increase of 4000 in the month. The principal changes were in the manufacturing group classified as "engineering, metal goods and precision instruments," where there was an addition of 2000, making the total labour force 2,612,000, and in vehicle building, where an addition of 3000 in February brought the total number employed to 1,165,000. Among the changes noted in other industries and services in February was a drop of 11,000 in the number at work in building and contracting, the total at the end of the month being 1,384,000.

The unemployment figures published by the Ministry of Labour show the position at March 15th, when 342,866 people were registered as out of work, compared with 387,303 on February 15th. The March figure, which represented about 1·6 per cent of the total number of employees, included 16,347 who were described as temporarily stopped. The Ministry has also reported that in the week ended February 27th about 39,500 operatives in manufacturing establishments were on short time, losing eleven hours each on the average, and that 1,439,000 operatives were working, on an average, eight hours' overtime.

Easter School for Headmasters and Science Masters

Next week, Metropolitan-Vickers Electrical Company, Ltd., is holding an Easter school at Trafford Park, Manchester, for headmasters and senior science masters, the object being to give them a better appreciation of the opportunities offered to their pupils by the engineering industry. For some years past the company has organised summer schools for professors and lecturers in engineering at universities, and for heads of engineering departments at senior technical colleges.

At next week's school, which will continue from Wednesday to Friday, April 21st to 23rd, a detailed explanation will be given of the scope and methods of practical training provided by Metropolitan-Vickers in its apprentice training school and main factory. It is stated that there will be ample opportunity for the discussion of problems of mutual interest.

Europe's Steel Production

The United Nations Economic Commission for Europe shows in its *Quarterly Bulletin of Steel Statistics* that steel production continued to rise during the first two months of this year in Italy and the Netherlands, as well as in the United Kingdom. In Western Germany, France, Belgium, the Saar and Luxembourg, however, it remained roughly stationary and somewhat below the record levels of 1952 and early 1953.

European crude steel production (excluding U.S.S.R.) at 75,000,000 tons last year was a record and was 1 per cent higher than in 1952. The output of the European Coal and Steel Community countries was 40,000,000 tons, which was 5 per cent below the 1952 total. The *Bulletin* says that in Eastern Europe (i.e. Czechoslovakia, Eastern Germany, Hungary, Poland and Rumania) steel production last year totalled 12,000,000 tons, which was 13 per cent above the 1952 output.

Discussing trade in steel last year, the *Bulletin* states that exports of finished steel from the United Kingdom and from Western Germany increased in the fourth quarter of 1953, compared with the preceding three quarters, while exports from France and Belgium remained practically unchanged. An interesting development which is commented upon was the expansion of steel exports from Austria and the Netherlands, which both more than doubled last year, compared with 1952, and attained annual rates of nearly 500,000 tons in the October-November, 1953, period. A large proportion of these exports consisted of flat products from the continuous wide strip mills, which recently went into production in Austria and the Netherlands.

British Iron and Steel Production

British steel production reached a new record in March, the average weekly output of ingots and castings being 364,800 tons, which represents an annual production rate of 18,969,000 tons, compared with an annual rate of 18,272,000 tons a year ago. In the first quarter of this year steel production was at an annual rate of 18,777,000 tons. Pig iron production in March averaged 230,900 tons a week, and was thus at an annual rate of 12,007,000 tons. During the first quarter an annual output rate of 11,848,000 tons was maintained.

In presenting these figures the Iron and Steel Board says that during the first quarter of this year production has benefited by the new steelmaking capacity at Consett, and also by the full operation of the steelmaking furnaces which were completed at Lackenby last year. During this year further benefits may be expected from additional steelmaking capacity on the North-East Coast and in South Wales. There should be, in fact, the Board considers, sufficient capacity for the production this year of 18,500,000 tons of steel. About raw materials, the Board says that in the first quarter of this year the use of scrap in steelmaking was equivalent to 56 per cent of the production, indicating an annual rate of scrap usage of 10,500,000 tons. Scrap has been plentiful, home supplies having continued at a high level and supplies from overseas having been more readily available. The stocks of scrap at steel works are stated to be 200,000 tons above those of a year ago.

Colombo Plan Aid

The Treasury has stated that more British technicians are going to India to further the assistance which the United Kingdom is already giving to the modern locomotive building works at Chittaranjan. The British locomotive building industry has collaborated with the Indian Government in this project and British technicians have already visited the works, which employ 4000 men and at which production is to be stepped up to 150 locomotives a year.

At the end of last year a team of three rate-fixers and five operator demonstrators went from this country to Chittaranjan under a year's contract under the Colombo Plan technical co-operation scheme. In continuation of this aid, the United Kingdom Government is now meeting a further request from India for the services of thirteen more specialists for a period of two years. Three of these vacancies are being filled by the renewal of contracts of three members of the previous team who are at Chittaranjan, eight others are now going out from this country, and the filling of the two remaining vacancies is being negotiated.

Coal Output

The Ministry of Fuel and Power has reported that coal production in Great Britain in the first fourteen weeks of this year amounted to 64,641,300 tons, compared with 62,727,900 tons in the corresponding period of last year. The increase has come solely from deep-mined production, which, over the first fourteen weeks of the year, has exceeded last year's comparable output by more than 2,000,000 tons. Last week, the deep-mined output was 4,542,100 tons and that from opencast workings 222,700 tons, giving a total for the week of 4,764,800 tons. Coal consumption in the first thirteen weeks of this year, at 64,784,000 tons, including exports and bunkers, was about 2,000,000 tons more than in the corresponding period of 1953. Distributed stocks of coal on April 3rd were 13,225,000 tons.

Notes and Memoranda

Air and Water

FIFTH SEA LORD.—We are informed that Rear-Admiral A. N. C. Bingley has been appointed a Lord Commissioner of the Admiralty, Fifth Sea Lord and Deputy Chief of Naval Staff (Air) in succession to Vice-Admiral Sir Edmund Anstive.

LINER'S MAIDEN VOYAGE.—The P. and O. Line announces that the liner "Iberia," which is a sister ship to the "Arcadia," and is at present fitting out at the Belfast shipyard of Harland and Wolff, Ltd., is due to sail on her maiden voyage from London to Australia on September 28th.

CONTINENTAL TRAIN FERRY.—We are informed that the British Transport Commission has given authority to the Eastern Region to order a new train ferry for the Harwich-Zeebrugge Continental service. The order for the new vessel, which is expected to cost more than £600,000, has been placed with John Brown and Co. (Clydebank), Ltd., and when complete will replace the "Essex Ferry" and result in an economy of £20,000 per annum in operating the service.

Miscellanea

CHEMICAL SOCIETY.—At the recent annual general meeting of the Chemical Society, Professor W. Wardlaw, was elected president and Professor E. R. H. Jones, Professor R. P. Linstead and Professor H. W. Melville were elected vice-presidents.

OIL EXHIBITION.—An exhibition, "The Story of Oil," opened at the Science Museum, Exhibition Road, South Kensington, last week, and will remain open until May 9th. The exhibition, which has been developed by the Shell Petroleum Company, Ltd., demonstrates how science is applied to the search for oil, its production, transport and distribution.

BIRMINGHAM ENGINEERING CENTRE.—It is stated that all the available exhibition space at the new Birmingham Exchange and Engineering Centre has now been taken. The exchange, which will be opened in June, will be the only permanent engineering centre in the country, and will house a varied display of medium and light engineering products. The total number of exhibiting firms is 200.

VISITS OF FRENCH PRODUCTIVITY TEAMS.—The first of a number of productivity teams which the French Government is arranging to send to the United Kingdom has recently spent a week here studying trade union organisation and activity. The team, which consists of eight French trade unionists, has already visited Belgium and Sweden. The British Council has been responsible for the visit to this country.

NON-DESTRUCTIVE TESTING.—The Institute of Physics has drawn attention to the fact that its industrial radiology group has been reconstituted as the non-destructive testing group. The group is to hold a summer meeting in the Chancellor's Hall of the University, Birmingham, from July 7th to 10th. Full particulars can be obtained from Mr. B. R. Byrne, British Railways Research Department, Ashford Works, Kent.

NATURAL GAS SURVEYS.—The Minister of Fuel and Power stated in Parliament on Monday that, in connection with natural gas surveys, an area totalling about 3680 square miles in various parts of England and Wales had been chosen for prospecting purposes. He said that geophysical surveys were being carried out in Yorkshire and Lincolnshire, a deep borehole was being drilled in Scotland, and it was hoped soon to start deep drilling in Sussex.

NATIONAL SMOKE ABATEMENT SOCIETY.—The National Smoke Abatement Society has recently published its Year Book for 1954. The book includes the annual report of the Society, together with reports of the activities of its several divisions, and gives also a good deal of legislative and other information on the subject of smoke reduction. The year book is available, at one shilling, from the Society's headquarters at 30, Grosvenor Place, London, S.W.1.

RUST REMOVAL.—An "easing" oil, designed to free rusting fittings, has been introduced by Shell-Mex and B.P., Ltd. It is a high-quality graphited product containing ingredients giving it highly penetrating characteristics. The oil is designed to free quickly rusted fittings, such as nuts and bolts, door and gate hinges, window catches, taps and pipe joints, rusted-in screws and springs, &c. The graphite it contains makes it black, and the oil should be used with care and not for purposes where it may stain or damage.

MR. C. A. CLENCH.—We regret to learn of the death, on Saturday, April 3rd, of Mr. C. A. Clench, M.I.Mech.E., M.Inst. Fuel, who was chief generation engineer (construction) of the British Electricity Authority, London Division. Mr. Clench was fifty-four years of age. He was apprenticed to the British Thomson-Houston Company, Ltd., and served in the Royal Flying Corps during the 1914–18 war, after which he returned to the B.T.H. organisation. In 1927 he joined the London Power Company as a draughtsman and later became that company's senior assistant constructional engineer. He was appointed generation engineer (construction), London Division, on the formation of the British Electricity Authority and became chief generation engineer (construction) in 1951, with responsibility for all constructional works in the London Division—more than 750MW.

PATENT OFFICE LIBRARY EXTENSION.—An extension to the library of the Patent Office, Southampton Buildings, Chancery Lane, London, has now been completed. It is open to the public and gives immediate access to more than 3500 scientific and technical periodicals in all languages. These periodicals, covering the whole field of technical invention from agriculture to zinc, are now conveniently arranged on open shelves, and include items published since 1920. Earlier volumes of periodicals will continue to be supplied on demand. Another useful addition to the library is the provision of a special section for bibliographies and abstracts. It is stated that the extensions have been made possible by a general rearrangement of the library and by overhauling the wartime accumulation of unbound volumes. The arrears have been reduced from 22,000 to 14,000 in the past three years and will be further reduced to 10,000 by the end of this year.

MINES DIESEL LOCOMOTIVE FOR LIGHT RAILS.—A fifth model has recently been added to the range of flameproof diesel locomotives for underground service made by the Hunslet Engine Company, Ltd. This locomotive has been designed specifically to meet requirements introduced with the new Coal Mines (Locomotives) Regulations, 1949, in which locomotives up to 5 tons weight are allowed to run over 28 lb rails, whereas any heavier unit must have rails of 40 lb a yard or over. This new 45 h.p. locomotive can be supplied fully flameproofed and exhaust-conditioned for gassy mines; or exhaust-conditioned only, for metalliferous workings; or without flameproofing or exhaust-conditioning for surface duties. The general construction of the new locomotive is similar to that of the other underground diesels made by the firm with a Gardner oil engine, a Hunslet clutch and mechanical transmission and jackshaft drive to steel-tyred wheels. The oil engine is set to give 45 b.h.p. at 1700 r.p.m., and with this speed the transmission gives track speeds of 5 and 10 m.p.h. in either direction. Tractive efforts of 2800 lb and 1400 lb are available in the two gear steps.

INSTITUTE OF METALS.—The Institute of Metals is holding its spring meeting this year jointly with the Société Française de Métallurgie. The meeting will take place in London from Monday to Saturday, April 26th to May 1st, and will continue in provincial centres on Monday and Tuesday, May 3rd and 4th. The May Lecture of the Institute of Metals will be delivered on Monday, April 26th, by Professor L. F. Bates, F.R.S., on the subject of "The Domain Structure of Ferromagnetic Metals." The meeting will be held at the Royal Institution of Great Britain, Albemarle Street, London, W.1, beginning at 6.30 p.m. On Tuesday morning at 10 a.m., the annual general meeting of the Institute of Metals will be held at the Church House, Westminster, S.W.1, at which Dr. S. F. Dorey, F.R.S., will be inducted as president and will deliver his address. A banquet and dance are arranged to take place at Grosvenor House, Park Lane, W.1, on Wednesday evening. The programme also includes morning sessions for the presentation and discussion of papers, and afternoon visits to works and research establishments. The provincial areas to be visited on May 3rd and 4th by the Société Française de Métallurgie are Birmingham, Cambridge, Sheffield and South Wales.

SYMPOSIUM ON POWDER METALLURGY.—The Iron and Steel Institute, in association with the Institute of Metals, is organising a symposium on "Powder Metallurgy," to be held on Wednesday and Thursday, December 1st and 2nd next, at Church House, Westminster, London, S.W.1. On both days there will be morning and afternoon sessions for the discussion of the papers, which will cover both ferrous and non-ferrous aspects of powder metallurgy. A small exhibition of powder metallurgy components is also being prepared. The arrangements have been entrusted to an organising committee, of which Dr. Ivor Jenkins is chairman and Mr. K. Headlam-Morley, secretary. Many papers are being specially written for the symposium and will be presented and discussed in the following three main groups: metal powders and their assessment, research and production practice, and production and properties of engineering materials. The symposium will be open to all interested in powder metallurgy, whether members of the Iron and Steel Institute and Institute of Metals or not. Anyone wishing to receive further particulars, the programme of the meeting and a form of application when available, should write to the Secretary, the Iron and Steel Institute, 4, Grosvenor Gardens, London, S.W.1, asking to be placed on the mailing list for this purpose.

Personal and Business

MR. THEODORE G. MONTAGUE has been elected a director of the International Nickel Company of Canada, Ltd.

NEWAGE (CANADA), Ltd., has moved into a new factory at Bestobell Road, Queen Elizabeth Way, Toronto, 14, Canada.

MR. W. H. L. HEWITT is joining the board of A.K. Fans, Ltd., 20, Upper Park Road, London, N.W.3, on May 1st.

LLOYD'S REGISTER OF SHIPPING announces the appointment of Mr. G. Buchanan as principal surveyor at Sunderland.

MR. H. L. WICKES, A.M.I.E.E., has been appointed sales manager of B.K.B. Electric Motors, Ltd., Birmingham.

AIR VICE-MARSHAL C. E. H. ALLEN, C.B., M.I.Mech.E., has joined the aviation division of the Dunlop Rubber Company, Ltd.

ARMSTRONG SIDDELEY MOTORS, Ltd., announces the appointment of Flight Lieutenant A. Wittridge as an engine test pilot.

MR. C. C. LAST, director and joint general manager of Bakelite, Ltd., has been elected vice-chairman of the British Plastics Federation.

MR. J. F. BYFIELD has been appointed sales director of S. N. Bridges and Co., Ltd., Bridges Place, Parsons Green Lane, London, S.W.6.

MR. J. A. BROOKS has been appointed superintendent, motor department, of Metropolitan-Vickers Electrical Company, Ltd., Trafford Park, Manchester.

MR. E. H. BAKER, M.I.Mech.E., has been appointed divisional motive power superintendent at Crewe in the London Midland Region of British Railways.

CHEMICAL ENGINEERING WILTONS, Ltd., has changed its address to Cheadle Heath, Stockport (telephone, Gatley 5231; telegrams, Wiltonstil, Stockport).

THE SOUTH WESTERN ELECTRICITY BOARD states that Mr. C. J. Blackett, Bristol district engineer, has been appointed district commercial manager for Bristol South.

MR. J. T. MOORE, M.I.C.E., is relinquishing his post as chief engineer of the English Electric Company, Ltd., having been appointed a director of Ewbank and Partners Ltd.

THE NATIONAL INDUSTRIAL FUEL EFFICIENCY SERVICE has now been established in headquarters at 71–72, Grosvenor Street, London, W.1 (telephone, Hyde Park 9706).

MARRYAT AND SCOTT, Ltd., Hounslow, announces the appointment of Mr. S. Cornthwaite as Midlands sales manager. He will operate from 41, Water Street, Birmingham.

THE MINISTRY OF LABOUR states that the electrical branch of the factory department is now at 40–41, York Terrace, Regents Park, London, N.W.1 (telephone, Museum 5030).

THE HAMWORTHY ENGINEERING COMPANY, Ltd., and British Combustion Equipment, Ltd., have transferred their Glasgow office to 163, St. Vincent Street, Glasgow, C.2 (telephone, Central 7751).

THE ELECTRIC CONSTRUCTION COMPANY, Ltd., Bushbury Engineering Works, Wolverhampton, announces the retirement of Mr. W. J. Stay, chief engineer, after forty-seven years in the company's service.

HOLDEN AND BROOKE, Ltd., Sirius Works, Manchester, 12, announces a merger with Frank Pearn and Co., Ltd., by which Holden and Brooke, Ltd., becomes the sole manufacturer and supplier of Pearn pumps.

VACUUM OIL COMPANY, Ltd., and Associated Coal and Wharf Companies, Ltd., have announced an arrangement whereby the latter concern undertakes the marketing on the South Coast of the Vacuum fuel oils produced at the Coryton refinery.

THE GENERAL ELECTRIC COMPANY, Ltd., states that Mr. J. F. Prince and Mr. A. E. Taylor have been appointed deputies to Mr. T. G. Travis, sales manager at the Witton works. They will deal respectively with export and home sales.

BOVING AND CO., Ltd., 56, Kingsway, London, W.C.2, states that Mr. O. Thott, M.I.Mech.E., who has been managing director since 1931, has been elected vice-chairman. He is succeeded as managing director by Mr. D. A. Akins, A.M.I.C.E.

CRONE AND TAYLOR, Ltd., Sutton Oak, St. Helens, Lancs, announces that to deal with its manufacturing business it has formed two subsidiary companies to be known as Crone and Taylor (Engineering), Ltd., and Crone and Taylor (Fertilisers), Ltd.

ALEXANDER STEPHEN AND SONS, Ltd., announces that Mr. John Robson, the company's naval architect, and Captain N. J. H. D'Arcy, R.N. (Ret.), have been elected directors in succession to Dr. A. S. Maclellan and Mr G. R. Grange, who have retired from the board.

METROPOLITAN-VICKERS ELECTRICAL COMPANY, Ltd., states that Mr. S. McCracken, M.I.E.E., has been appointed a director of Metropolitan-Vickers South Africa (Pty.), Ltd. He is succeeded as manager of the Metropolitan-Vickers Belfast office by Mr. F. W. Cox, M.I.E.E.

MR. H. F. FARMER has retired from the British Thomson-Houston Company, Ltd., Rugby, after nearly forty-eight years' service. Up till the end of 1951 he was superintendent of the control gear factory, and since then has been engaged in consulting work for the company.

ASHMORE, BENSON, PEASE AND CO., Ltd., Stockton-on-Tees, states that it has made an agreement with General American Transportation Corporation, Chicago, U.S.A., to manufacture the Wiggins "Hidek" and "Lodek" floating roof structures for the petroleum and petrochemical industries.

Contracts

THE HUNSLET ENGINE COMPANY, Ltd., Leeds, has received an order from the National Coal Board for two 30-ton, 204 h.p. diesel-mechanical, six-wheel locomotives for shunting at the new Grassmoor coking plant near Chesterfield.

THE FRASER AND CHALMERS ENGINEERING WORKS OF THE GENERAL ELECTRIC COMPANY, Ltd., has received an order from the National Coal Board, South-Western Division, for a Chance coal preparation plant for the Onllwyn group of collieries. The order includes electrical equipment for pumps, crushers, and conveyors, together with the electrical equipment necessary for the small coal washery for cleaning 4in by 0in sizes, and for the run-of-mine screening plant which is being supplied by the Norton-Harty Engineering Company, Ltd.

British Patent Specifications

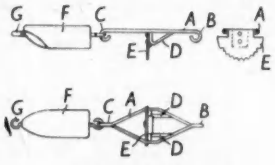
When an invention is communicated from abroad the name and address of the communicator are printed in italics. When an abridgment is not illustrated the specification is without drawings. The date first given is the date of application; the second date, at the end of the abridgment, is the date of publication of the complete specification.

Copies of the specifications may be obtained at the Patent Office Sales Branch, 15, Southampton Buildings, Chancery Lane, W.C.2, 2s. 8d. each.

CIVIL ENGINEERING

704,646. January 10, 1952.—Device for Cleaning Sewers, Robert MacRae, 52, Townhead, Kirkintilloch, Stirlingshire, Scotland, and Margaret Watt, 15, Thomson Avenue, Johnstone, Renfrewshire, Scotland.

The drawings show a side elevation of the device, a section and a plan view. *A* is a flat lozenge-shaped frame presenting at its ends hooks *B* and *C*. *D* are skids projecting out of the frame and *E* is a serrated blade pivoted to the frame. *F* is a weight coupled to one of the hooks *C* and presenting a hook *G* for attachment to an operating cable. In practice, the hook *B* at the rear end of the frame *A* is attached to



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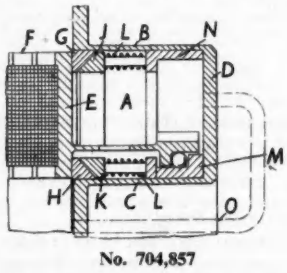
the feeding rope and the frame is dragged backwards through the sewer, the skids *D* resting on the bottom of the sewer and the blade *E* swinging upwards towards the frame to avoid silt lying on the bottom of the sewer. A cable attached to the hook *G* is then pulled to drag the device through the sewer in the forward direction, the blade *E* thereupon swinging away from the frame against the skids *D* to entrain silt in the bottom of the sewer, and to push the silt in front of the device, where it collects in the nearest gully ready for removal.—*February* 24, 1954.

HEAT EXCHANGERS

704,857. May 3, 1950.—Sealing Arrangements for Rotary Type Regenerative Heat Exchangers, C. A. Parsons and Co., Ltd., Heaton Works, Newcastle upon Tyne, 6, and Paul Kolb, formerly of 14, Ventnor Gardens, Whitley Bay, and now of the company's address.

Referring to the drum type exchanger shown in the drawing, in order to prevent gas leakage a seal is provided which consists of a four-walled annular chamber *A* which is formed by outer and inner cylindrical walls *B* and *C* respectively connected by a radial wall *D*. These three walls form part of the stator. The fourth wall *E* is formed by the end of the rotating drum *F*. In the annular chamber *A* two sealing rings *G* and *H* are pressed axially against the



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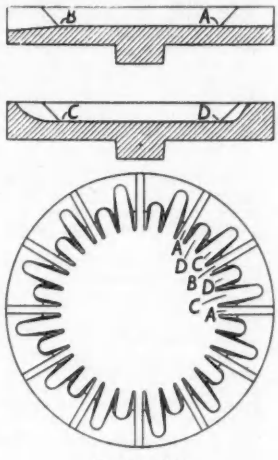
surface of the rotating wall *E* and radially against the surfaces of the outer and inner walls *B* and *C* respectively. The sealing rings are made triangular in section and are pressed by the spring-loaded rings or parts of rings *J* and *K* of similar shape. The springs are compressed between the rings *J* and *K* and the casing directly or indirectly through a part *M* forming a spacing ring and a part *N* forming a locating ring for a ball bearing for the rotating drum enabling assembly of the ball face to be effected as shown. The annular chamber *A* contains air of the same pressure and virtually the same temperature as the air inside the rotor by communication with the space by channels *O*. Due to the difference in pressure between the high-pressure inner space and, hence, the annular chamber and the other spaces of the heat exchanger, a flow of cold air is ensured in the chamber and this cools the bearing as well as the sealing. In addition, this high-pressure cooling air in the chamber *A* acts to oppose the pressure on the seal exerted by the gases leaking across the rotor, and in this respect reduces the sealing pressure which must be exerted by the springs. There will also be a resultant force exerted by the high-pressure air in the chamber on the rings *J* and *K* due to the difference between the inner and outer peripheral areas of the rings, this resultant also helping to press sealing rings *G* and *H* against the wall *E* of the rotor and walls *C* and *B* of the stator. An application of the invention to a disc type of regenerator is also shown in the specification. —*March* 3, 1954.

705,263. October 17, 1950.—Spray Plate for the Cooling of Water, Maschinenbau-Aktiengesellschaft Balcke, 5, Marienplatz, Bochum, Germany.

The invention relates to spray plates for use in cooling towers. It is important to break up the water into very small drops so as to expose as large a water surface as possible to the air. If, for example, a drop of water has a diameter D=4mm, its volume V=33,51mm³ and its surface area O=50,28mm². If



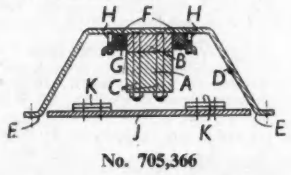
No. 705,263

however, this one drop is broken up into drops having a diameter D^1=2mm, then there are obtained eight drops having a total volume $V^1=8\times4,188=33,51mm^3$ and a total surface $O^1=8\times12,57=100,56mm^2$. Thus the surface area is doubled. As will be seen from the drawing, arranged at an equal distance from the centre of the plate, there is a number of narrow upwardly projecting distributing ribs which bound a central dish-shaped trough. The ribs are separated from one another by narrow radial grooves *A* and *B*, the grooves *A* having their bases at the same level as the surface of the central trough, while the grooves *B* are slightly downwardly inclined towards the rim of the plate. Other grooves *C* and *D* are provided in each rib and grooves communicate with the central trough, but terminate inside the rim of the plate. Grooves *C* are formed to a relatively flat curvature and the grooves *D* to a steeper curvature. The grooves *C* and *D* are wider than the grooves *A* and *B*. In operation the descending jet of water to be cooled strikes the central trough portion of the spray plate and spreads outwardly towards the rim of the plate. Due to the formation of the respective grooves and to their disposition around the plate, the water is projected outwardly in narrow streams comprising drops of small size, in a number of curved or parabolic paths—four in the arrangement illustrated—which avoid the formation of a wall or curtain of water. Thus, by spreading the water over a greater area around each plate more efficient cooling of the water and improved circulation of the cooling air are effected.—*March* 10, 1954.

RAILWAY ENGINEERING

705,366. November 17, 1949.—Railway Signalling Systems, Metropolitan-Vickers Electrical Company, Ltd., St. Paul's Corner, 1–3, St. Paul's Churchyard, London, E.C.4. (*Inventor: Sydney Crosbie.*)

The invention relates to railway signalling systems of the kind in which a magnet mounted on the track actuates apparatus installed in a locomotive or other vehicle. Referring to the drawing, a vertically



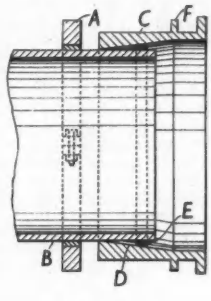
No. 705,366

magnetised permanent magnet *A*, with a soft iron pole piece *B* at its upper end, is suspended by through bolts *C* from the top side of a cover *D* which covers the complete assembly and is provided with flanges *E* for mounting on the track. A coil *F* surrounds the pole piece *B*, being supported on a platform *G*, which is suspended from the top of the cover by bolts *H*. The open underside of the cover is closed by a plate *J* secured to the ends of the cover by angle members *K*. The leads for conveying energising current to the coil *F* may be brought through a cable box secured on the cover *D*. When the assembly is in position on the track and the coil *F* is de-energised flux from the permanent magnet *A* extends vertically upwards and is effective to operate apparatus installed in a vehicle passing over the assembly. When, however, the coil *F* is energised, the vertical flux is so reduced that a vehicle may pass over without the apparatus installed in it being operated.—*March* 10, 1954.

TUBE AND PIPE COUPLINGS

705,182. April 10, 1951.—Stopping the Ends of Pipes, Tate Pipe Lining Processes, Ltd., 39, Victoria Street, Westminster, London, S.W.1. (*Inventor: Robert Hugh Shuttleworth Pether-bridge.*)

The drawing shows a fitting for use on a water main of 10in diameter. A two-part ring *A* is placed around the pipe *B*, at a distance of, say, 18in., from the end to be stopped, and is fastened by drawing the two halves of the ring together. There is then pushed on to the end of the pipe one end of a metal sleeve *C* which has a tapering side *D* and a cylindrical end which extends beyond the extremity of the pipe. A resilient sealing ring *E*, such as rubber, is then placed on to the pipe end and inserted into the space between the outer wall of the pipe and the inner face of the tapering portion of the sleeve. On the outer face of the sleeve is a ring, or a number of lugs *F*, between which, or the lugs, and the two-part ring *A* a hydraulic jack is inserted, to push the tapering wall of the sleeve on to the resilient ring, which becomes compressed against the pipe. The overhanging outer cylindrical end of the sleeve is flanged, and there is then attached to it a plate which effectively closes the end of the sleeve and the pipe. When the water is turned on the pressure tends to force the sleeve *C* off the pipe, and makes it tighter on to the sealing ring *E*. When the pressure becomes sustained the hydraulic jacks are taken away.—*March* 10, 1954.



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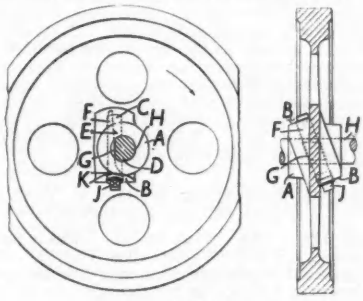
INTERNAL COMBUSTION ENGINES

705,155. May 8, 1950.—Securing Flywheels, Blackstone and Co., Ltd., Rutland Engineering Works, Stamford. (*Inventor: George Hallewell.*)

As the drawing shows, the flywheel is substantially symmetrical, the boss *A* preferably having flats *B* opposite to one another perpendicular to the required axis of the pin. A hole *C* is drilled inclined to the axis



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of the hole *D* in the boss, the centre of the hole *C* preferably falling about where the flat *E* on the pin *F* will start to engage a flat *G* on the shaft *H* subtending about 90 deg. The part of the pin engaging the shaft will thus approximate the semi-circular cross section and the centre of the engaging flats will lie in a plane central of the wheel boss and perpendicular to the axis of rotation. A screwed plug hole is tapped in the flywheel hole at the larger end of the pin into which a plug *J* is inserted and abuts on to the end of the pin. The pin *E* is of normal construction in that the flat *F* formed on its surface terminates in a cylindrical surface *K*, thus providing the full diameter of the pin for the screw plug to abut against and drive home to lock the flywheel securely to the shaft. The flat cut in the shaft is inclined and its width is only slightly larger than the diameter of the pin, thus locating the wheel axially along the shaft. The locking force created when the pin is driven home tight exerts a resultant force acting at the centre of the boss, thus tending to maintain the plane of the wheel at right angles to the crankshaft axis. By setting the pin inclined to the axis of the shaft both ends of the pin are easily accessible for insertion and removal. —*March* 10, 1954.

British Standards Institution

All British Standard Specifications can be obtained from the Sales Department of the Institution at 2, Park Street, London, W.1.

COPPER AND COPPER ALLOY CAPILLARY AND COMPRESSION TUBE FITTINGS FOR ENGINEERING PURPOSES.

No. 2051, part 1 : 1953. Price 3s. This standard deals with three types of tube fittings for engineering purposes in sizes ranging from ¼in. to 1in inclusive. The fittings are for use in conjunction with copper, copper alloy and other suitable tubing, including the following : capillary fittings in which the joint is made by a flow of solder by capillarity along the annular space between the outside of the tube and the inside of the socket of the fitting, the size of this annular space being dimensionally accurate within close limits ; compression fittings, type " A," in which the joint is made by the compression of a ring or sleeve or part of the fitting on to the outside wall of the tube ; and compression fittings, type " B," in which the joint is made by the compression of a manipulated portion of the tube at or near its end against true faces of the body of the fitting or against a loose ring or sleeve within the fitting.

This standard does not attempt the complete dimensional standardisation of any of the types of fittings, since the variety in the designs and methods of production already established by the various manufacturers makes any such attempt impracticable. Without seeking to limit the individual refinements of design, which are the distinctive feature of the proprietary product, this standard does, however, lay down such dimensions and requirements as are essential to ensure satisfactory installation and performance.

The fittings covered are for use with tubes designated by their outside diameters in inches and fractions of an inch.

GEAR HOBS

No. 2062 : 1953. Price 5s. It has long been recognised that the sizes of hobs for general purposes should be restricted in number and their limits of accuracy closely defined. The present specification covers in Part 1 the range 1 to 50 D.P. for general-purpose hobs intended for the production of gears complying with the basic rack tooth profile given as Fig. 5 of B.S. 436 : 1940. Three grades of accuracy are specified as follows :— A. precision ground hobs, B. ground hobs, D. unground hobs. The tolerances in Table 4 are in close agreement with those of the American Gear Manufacturers' Association. A useful addition to the specification is given in Appendix B, which lists the sizes of hobs with taper bores and of taper arbors in current use in industry. At the request of manufacturers and users of turbine gears, Part 2 has been added, with Table 5 setting out limits of accuracy only for hobs intended for the production of gears complying with B.S. 1807 : 1952, " Gears for Turbines and Similar Drives, Part 1 : Accuracy." This table is based on the specification issued by the Mechanical Engineering Research Laboratory of the Department of Scientific and Industrial Research for the " Accuracy of Gear Cutting Hobs for Marine Turbine and Similar Drives," and which has been in use for several years. It must be noted that Part 2 does not cover tooth form design.

SIZES OF SENSITISED MATERIAL FOR RECORDING INSTRUMENTS

No. 1193 : 1954. Price 2s. 6d. This standard supersedes B.S. 865 : 1939 as well as B.S. 1193 : 1945. The perforation pitch of the 70mm film previously dealt with in B.S. 865 has been brought into line with that for the other film sizes.

This edition also includes 80mm film used in mass radiography, and this size is suggested as the preferred standard for future recording apparatus requiring a width of film of the order of 70–120mm. In addition, the method of specifying dimensions for perforated material has been revised to conform to the method of measurement used in their production.

ROPES MADE FROM COIR, HEMP, MANILA AND SISAL

No. 2052 : 1953. Price 10s. This standard, which has been prepared in collaboration with the Joint Equipment Standardisation Committee of the Ministry of Defence, is intended to provide a range of ropes which will meet both Government and commercial requirements. It supersedes B.S. 431 : 1946 " Manila Ropes for General Purposes," and B.S. 908 : 1946, " Sisal Ropes for General Purposes."

The standard provides the following ranges of ropes :—Sisal, three-strand, four-strand and nine-strand ; manila, three-strand, four-strand and nine-strand, each in three grades of quality ; coir, three-strand; and Italian hemp, three-strand. The ropes are available plain or hawser laid for three-strand types ; shroud laid for four-strand types, and cable laid for nine-strand types. In accordance with accepted trade practice, the sizes of the ropes are based on circumference and not on diameter.

The specification deals with quality of materials, construction, length, weight, breaking load, finish and packing. Methods of test for verifying compliance with the requirements are included.

Launches and Trial Trips

TARIM, oil tanker ; built by the Netherlands Dock and Shipbuilding Company, for Wilhelm Wilhelmsen, Oslo ; length between perpendiculars 600ft, breadth moulded 76ft 6in, depth 43ft, deadweight 25,200 tons on 33ft 1½in summer draught, trial speed 15·9 knots ; twenty-seven oil cargo tanks, two pump rooms, six horizontal duplex oil cargo steam pumps ; one set of N.D.S.M.-Parsons double-reduction geared turbines, steam supplied at 500 lb per square inch and 800 deg. Fah. by two N.D.S.M.-Babcock and Wilcox water-tube boilers, two 500kW turbine-driven alternators, one 100kW diesel-driven generator. Launch, March 27th.

SHER AFGAN, river passenger ship ; built by Chantiers Dubigeon, for the Eastern Pakistan Railways ; length between perpendiculars 226ft 5in, beam 31ft 6in, depth 8ft 3in, load draught 4ft 7½in, speed 13 knots ; 700 passengers in three classes ; seven watertight compartments ; two 50kW diesel-driven generators ; four 300 h.p. Duvant diesel engines running at 600 r.p.m. drive two propellers at 300 r.p.m. through gearing. Trial, March.

NORVEST, oil tanker ; built by Smith's Dock Company, Ltd., South Bank-on-Tees, for the Bergen Kulkompani A/S, Bergen ; length between perpendiculars 315ft, breadth moulded 47ft 6in, depth moulded to harbour deck 21ft 3in, deadweight 4071 tons on 19ft 7½in draught ; service speed 11½ knots ; six centre tanks, eight wing tanks, one pump room, two 250 tons per hour cargo oil pumps, steam deck machinery ; No. 7 Fredriksstad steam motor, 1600 i.h.p. ; steam supplied at 220 lb per square inch by two three-furnace, multitubular cylindrical, oil-fired boilers.

PACIFIC NORTHWEST, cargo and passenger liner ; built by Vickers-Armstrongs, Ltd., at Walker-on-Tyne for Furness Withy and Co., Ltd.; length between perpendiculars 470ft, breadth moulded 63ft 2in, depth moulded 41ft, load draught 28ft 6in, deadweight 10,740 tons, gross tonnage 9442, refrigerated capacity 132,000 cubic feet ; twelve passengers ; two complete steel decks, five main holds, derrick complement includes two 10-ton and one 25 tons capacity, electric deck machinery, Cargocaire hold ventilation system ; one set of Parsons triple-expansion, double-reduction geared turbines, 7700 s.h.p. at 115 r.p.m. at the propeller, steam supplied at 450 lb per square inch and 750 deg Fah. by two Yarrow three-drum pattern water-tube boilers ; four 250kW diesel-driven generators. Trial March.

Forthcoming Engagements

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of their insertion, the necessary information should reach this office not later than a fortnight before the meeting. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

BRITISH INSTITUTION OF RADIO ENGINEERS

Wed., April 21st.—LONDON SECTION : School of Hygiene and Tropical Medicine, Keppel Street, Gower Street, W.C.1, " Crystal Valves in Radio and Electronics," B. R. A. Bettridge, 6.30 p.m.

INCORPORATED PLANT ENGINEERS

Wed., April 21st.—GLASGOW BRANCH : Scottish Building Centre, 425/427, Sauchiehall Street, Glasgow, " Hospital Heating : Modern Methods," W. Russell, 7 p.m.——KENT BRANCH : Bull Hotel, Rochester, " Self-Oiling Bearings," 7 p.m.——WESTERN BRANCH : Grand Hotel, Bristol, " The Gas Turbine Locomotive," 7.15 p.m.

INSTITUTE OF BRITISH FOUNDRYMEN

Thurs., April 22nd.—LINCOLNSHIRE BRANCH : Technical College, Lincoln, General Meeting and Short Paper Competition, 7.15 p.m.——SOUTHAMPTON SECTION : Technical College, St. Mary Street, Southampton, " Methods Employed in the Production of Heavy Iron Castings," J. Richardson and C. F. Lawson, 7 p.m.

INSTITUTE OF MARINE ENGINEERS

Thurs., April 22nd.—N.E. COAST SECTION : Technical College, West Hartlepool, " Water Treatment," J. T. Aynsley, 7 p.m.

INSTITUTE OF NAVIGATION

Fri., April 23rd.—Royal Geographical Society, 1, Kensington Gore, London, S.W.7, " Surface Currents and Their Effects on Navigation," E. W. Barlow and C. E. N. Frankcom, 5 p.m.

INSTITUTE OF REFRIGERATION

Tues., April 27th.—Institution of Mechanical Engineers, 1, Birdcage Walk, Westminster, London, S.W.1, " Valve Behaviour and the Performance of Small Compressors," J. F. T. MacLaren, 5.30 p.m.

INSTITUTE OF ROAD TRANSPORT ENGINEERS

Wed., April 21st.—N.W. CENTRE : Victoria Hotel, Wigan, Annual General Meeting, 7.30 p.m.

Thurs., April 22nd.—LONDON CENTRE : Royal Society of Arts, John Adam Street, Adelphi, W.C.2, " Some Factors Affecting Fuel Consumption," W. T. Skinner, 6.30 p.m.

Mon., April 26th.—SCOTTISH CENTRE : Institution of Engineers and Shipbuilders, 39, Elmbank Crescent, Glasgow, Annual General Meeting, 7.30 p.m.

Tues., April 27th.—N.E. OF ENGLAND GROUP : Royal County Hotel, Durham, Annual General Meeting, 7 p.m.

INSTITUTE OF WELDING

Wed. to Sat., April 28th to May 1st.—SPRING MEETING : Wed., April 28th : Grand Pavilion, Porthcawl, Informal Gathering and Technical Film Show.—Thurs., April 29th, morning : Grand Pavilion, Porthcawl, " Steelmaking and Welding," L. Reeve ; " Hydrogen : Barrier to Welding Progress," C. L. M. Cotrell ; afternoon : Visit to the Abbey Works of the Steel Company of Wales, Ltd., Port Talbot.—Fri., April 30th, morning : Grand Hotel, Bristol, " Nitrogen-Arc Welding of Copper," E. Davis and C. A. Terry; " Nitrogen-Arc Welding of Copper," K. Winterton ; afternoon : Choice of Works Visits ; evening : Grand Hotel, Bristol, Dinner.—Sat., May 1st, morning : Grand Hotel, Bristol, " Welding in the Aero-Engine Industry : Reflections on Organisation by a Production Engineer," F. G. C. Sandiford ; " Welding as a Career," P. Koenigsberger.

INSTITUTION OF CIVIL ENGINEERS

Tues., April 27th.—ORDINARY MEETING : Great George Street, Westminster, London, S.W.1, James Forrest Lecture, " The Geological Survey of Great Britain," W. J. Pugh, 5.30 p.m.

Fri., April 30th.—YORKSHIRE ASSOCIATION : Royal Victoria Station Hotel, Sheffield, Annual General Meeting. " Land Drainage in England and Wales," E. A. G. Johnson, 7 p.m.

INSTITUTION OF ELECTRICAL ENGINEERS

Tues., April 20th.—S.E. SCOTLAND SUB-CENTRE : Carlton Hotel, North Bridge, Edinburgh, Annual General Meeting, 7 p.m.

Thurs., April 22nd.—UTILIZATION SECTION : Savoy Place, London, W.C.2, " Safety in the Use of Portable and Transportable Electrical Equipment in Industry," J. Bunting, 5.30 p.m.

Fri., April 23rd.—EDUCATION DISCUSSION CIRCLE : Savoy Place, London, W.C.2, Discussion on " A Method for the Plotting of Magnetic Fields Due to Currents," opened by F. T. Chapman and D. G. Sandeman, 5.30 p.m.

Mon., April 26th.—RADIO SECTION : Savoy Place, London, W.C.2, " The Experimental Synthesis of Speech," W. Lawrence, 5.30 p.m.

Tues., April 27th.—MEASUREMENTS SECTION : Savoy Place, London, W.C.2, " Auto-Self-Excited Transductors and Push-Pull Circuit Theory," A. G. Milnes and T. S. Law, " Composite Cores for Instrument Transductors," E. H. Frost-Smith and A. E. De Barr, 5.30 p.m.

Wed., April 28th.—SUPPLY SECTION : Savoy Place, London, W.C.2, " Aluminium Sheathed Cables," P. M. Hollingsworth and P. A. Raine, 5.30 p.m.

Thurs., April 29th.—ORDINARY MEETING : Savoy Place, London, W.C.2, Kelvin Lecture, " The Physics of the Ionosphere," J. A. Ratcliffe, 5.30 p.m.

INSTITUTION OF LOCOMOTIVE ENGINEERS

Wed., April 21st.—Institution of Mechanical Engineers, 1, Birdcage Walk, Westminster, London, S.W.1, " Locomotive Diagramming and Utilisation," L. C. Welborn, 5.30 p.m.

INSTITUTION OF MECHANICAL ENGINEERS

Wed., April 21st.—N.E., A.D. CENTRE : The University, Leeds, " Operating Experiences with a 750kW Gas Turbine," G. B. R. Feilden, 7.30 p.m.

Fri., April 23rd.—GENERAL MEETING : 1, Birdcage Walk, Westminster, London, S.W.1, James Clayton Paper, " A New Frontier : Air-Pollution Control," Frederick S. Mallette, 4.15 p.m.——SOUTHERN A.D. CENTRE : The University, Southampton, Annual General Meeting, 7.30 p.m.

Mon., April 26th.—N.W. BRANCH : College of Technology, Sackville Street, Manchester, James Clayton Paper, " A New Frontier : Air-Pollution Control," Frederick S. Mallette, 6.45 p.m.

Wed., April 28th.—EDUCATION GROUP DISCUSSION : 1, Birdcage Walk, Westminster, London, S.W.1, " The Mathematical Content of Engineering Courses," 6.45 p.m.——E. MIDLANDS BRANCH : Technical College, Lincoln, " Contemporary Methods of Watch Production," R. A. Fell and P. Indermuhle, 7.30 p.m.——WESTERN A.D. CENTRE : Grand Hotel, Bristol, Annual General Meeting and Film Show, 7 p.m.

INSTITUTION OF MINING AND METALLURGY

Thurs., April 22nd.—GENERAL MEETING : Geological Society, Burlington House, Piccadilly, London, W.1, Discussion of Papers, " Production of Asbestos in South Africa," W. E. Sinclair, and " Geochemical Prospecting at Mt. Isa, Queensland," A. H. Debnam, 5 p.m.

INSTITUTION OF PRODUCTION ENGINEERS

Tues., April 20th.—LONDON GRADUATE SECTION : 36, Portman Square, London, W.1, " Machine Tool Replacement," T. P. N. Burness, 7.15 p.m.

Wed., April 21st.—BIRMINGHAM SECTION : James Watt Memorial Institute, Great Charles Street, Birmingham, " Some Thoughts on the Training of the Young Engineer," J. Wilson, 7 p.m.

Mon., April 26th.—MANCHESTER SECTION : Reynolds Hall, College of Technology, Sackville Street, Manchester, " Modern Gear Production," H. J. Watson, 7.15 p.m.

Tues., April 27th.—LUTON SECTION : Town Hall, Luton, " Packaged Power," Film and Lecture, 7.15 p.m.

INSTITUTION OF STRUCTURAL ENGINEERS

Thurs., April 22nd.—11, Upper Belgrave Street, London, S.W.1, " Fatigue of Welded Structures," R. Weck, 5.55 p.m.

IRON AND STEEL INSTITUTE

Mon. to Thurs., April 26th to 29th.—MEETING OF JUNIOR ENGINEERS : Buxton, Derbyshire.

JUNIOR INSTITUTION OF ENGINEERS

Fri., April 23rd.—ORDINARY MEETING : Townsend House, Greycoat Place, London, S.W.1, " Engineering Maintenance in a Paper Mill," N. A. Holmes, 7 p.m.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS

Fri., April 23rd.—Mining Institute, Neville Hall, Newcastle upon Tyne, " Some Practical Effects of Tip Clearance in Turbine Blading," J. L. Jefferson, 6.15 p.m.

ROYAL AERONAUTICAL SOCIETY

Thurs., April 22nd.—MAIN LECTURE : Institution of Mechanical Engineers, 1, Birdcage Walk, Westminster, London, S.W.1, " Diesel Compound Engines," E. B. Chatterton, 6 p.m.

Tues., April 27th.—SECTION LECTURE : 4, Hamilton Place, London, W.1, " Aerodynamic and Aero-Elastic Characteristics of the Crescent Wing," G. H. Lee, 7 p.m.

SHEFFIELD SOCIETY OF ENGINEERS AND METALLURGISTS

Mon., April 26th.—Mappin Hall, The University, St. George's Square, Sheffield, 1, Film Evening, 7.30 p.m.

SOCIETY OF INSTRUMENT TECHNOLOGY

Tues., April 27th.—MAIN MEETING : Manson House, Portland Place, London, W.1, " Instruments for Testing and Control in the Textile Industry," S. L. Anderson, 6.30 p.m.

WOMEN'S ENGINEERING SOCIETY

Tues., April 27th.—LONDON BRANCH : 35, Grosvenor Place, London, S.W.1, " Use of Models in Ship Design," D. J. Doust, 7 p.m.

Wed., April 28th.—MANCHESTER BRANCH : Engineers' Club, Albert Square, Manchester, " Some Aspects of Marine Propulsion," P. A. Fawcett, 6.45 p.m.